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THE PSYCHOLOGICAL REVIEW.

EXPERIMENTS ON HABIT FORMATION IN DEMENTIA PRÆCOX[1]

BY GRACE HELEN KENT

INTRODUCTORY

The population of our hospitals for the insane is made up very largely of cases of dementia præcox. Because of their prolonged residence in institutions, the patients suffering from this disease constitute a public burden of considerable importance.

These patients differ widely in respect to the symptoms which they manifest, and also in respect to their general behavior. Some are efficient workers, and if their activities are properly directed they show a remarkable persistence in the performance of the daily tasks which are assigned to them. Others manifest violent and destructive tendencies, and require almost constant watching on the part of the attendants. Still others show no active tendencies, either useful or harmful, but remain most of the time in a passive state; patients of this type may be seen in large numbers in any asylum, sitting idle about the wards and taking little notice of their surroundings.

That many demented patients possess the ability to perform useful labor is well known, and in public institutions it is customary to assign regular duties to such patients as can readily be induced to work. But, so far as the writer is aware, no attempt has been made to determine experimentally the capacity of dements to receive instruction. The possibility of substituting industrious habits for idle or destructive habits is an open question. It is commonly believed that occupation

[1] From the Psychological Laboratory of the Government Hospital for the Insane, Washington, D. C.

is beneficial to the patients themselves, and it is certain that the regular employment of these patients at some useful occupation would reduce the cost of their care. It is important, therefore, both in therapeutics and in economics, to determine what can be done to further the development of patient labor.

With this in view as the ultimate aim, this investigation was undertaken, the purpose being to show to what extent demented patients possess the ability to profit by experience in the performance of simple tasks. The methods adopted for this study were similar to those used by other investigators in studying the effects of practice; it was necessary, however, to simplify these methods very considerably, in order to adapt them to the ability of the subjects.

In most of these experiments the plan was followed of allowing the subjects a considerable range of freedom in the selection of a mode of procedure. The aim has been not so much to produce certain habits as to determine what habits will, under certain conditions, be spontaneously formed. This study will serve as the introduction to a further investigation, in which the primary aim will be to study the effects of definite and systematic training.

Experimental

1. *General Conditions of Experimentation*

Eighteen female patients served as subjects in these experiments. Forty patients[1] were examined in order to determine roughly their willingness to be experimented upon, and those were selected who, at the first interview, gave the best promise of coöperation. Those who could not be induced to perform a simple act according to instructions were eliminated, on the ground that it seemed inadvisable, in the early stages of the experiment, to spend a large amount of time working with patients from whom no coöperation could be expected.

Five experiments were undertaken, each comprising a series of about twenty tests upon at least six subjects. The intervals

[1] These patients were selected for me by Dr. Mary O'Malley as being fairly typical cases of dementia præcox. I wish here to express my gratitude to Dr. O'Malley for her cordial coöperation in this investigation.

between consecutive tests were usually two or three days, each subject being tested three times a week, on alternate days, for a period of several weeks; the regularity of the intervals was, however, occasionally disturbed by the illness of a subject. The tests were conducted in two of the hospital wards, a small bedroom in each of these wards being set apart for the purpose. Ordinarily the door was closed during the test period, but it was regularly left open during experiments upon patients who were considered dangerous.

The plan was to continue each series of tests upon each subject until the limit of practice improvement should be reached or at least approached, but in most instances it was impossible to carry out this plan. Some of the subjects found the tests irksome, and it became increasingly difficult, as the series progressed, to secure their coöperation. The tasks which were assigned to them possessed little or no intrinsic interest, and no external reward was offered for their performance; there was, therefore, no incentive present beyond the desire to gain the approval of the experimenter. During the first few interviews certain of the subjects frequently asked: "If I do this for you, will you ask the Doctor to let me go home?" It would appear from such questions that the hope of a reward served in some cases as an incentive to undertake the tasks, but great care was taken to avoid encouraging such hope, and there is nothing to indicate that it figured except during the first week, or at most, two weeks. Questions as to the purpose of the experiments were not encouraged, but occasionally, in response to a patient's inquiry, the explanation was given: "I want to see how quickly you can learn to do this, without making a single mistake."

In all these experiments the speed of the performance of an act constituted the principal, if not the only, recorded variable. An attempt was made to eliminate all other variables as far as possible, in order to simplify the treatment of the results. A stop watch was used for measuring the time, but no account was taken of fractions of seconds. As few of the subjects could be taught to begin the work at a signal, they were allowed to begin when they pleased, and the watch was started accordingly.

2. *First Series*

The first three experiments were conducted in the receiving ward, eleven patients serving as subjects. All were patients of comparatively recent admission to the hospital; some, however, were cases of several years' duration[1] at the time of admission. Two were high school graduates, and the others were women of common school education. At the time of the first interview they were quiet and orderly in their behavior, and could be prevailed upon, with more or less difficulty, to comply with any request.

The following notes are taken, for the most part, from the case histories.

Subject 1. Age twenty-seven. Duration two years. Spends her time sewing.

Subject 2. Age forty. Duration one year, convalescent. Obeys any request promptly, but when left to herself sits motionless with bowed head.

Subject 3. Age forty. Duration ten years, hospital residence three months. Dull and apathetic, sits with bowed head, does no work.

Subject 4. Age forty-two. Duration eight years. Busies herself at scrubbing and other rough work. Condition variable.

Subject 5. Age thirty-three. Duration two years. High school education; has held a responsible clerical position. During the period of observation her condition underwent a very considerable change for the worse.

Subject 6. Age twenty-eight. Duration seven years. Condition variable. Busies herself with reading, sewing, and playing the piano. Takes little interest in her surroundings.

Subject 7. Age twenty-five. Duration four years. Condition variable. Usually found sitting on the floor. Does some sewing.

Subject 8. Age thirty-five. Duration seven years. Silent, seclusive.

Subject 9. Age twenty-two. Duration five years. High school education. Spends her time reading.

Subject 10. Age twenty-eight. Duration two years. Works incessantly in the ward, dusting and polishing the floors; very slow in all her movements, and when at work presents the appearance of an automaton. Can rarely be induced to speak.

Subject 11. Age twenty-nine. Duration four years.

Description of Methods. Experiment A.—Rearrangement of digits. Fifteen digits, mounted on blocks of heavy cardboard, 13 by 50 mm. in size, were to be arranged according to a fixed scheme. There was a cardboard frame 36 × 40 cm., which was placed on the table before the subject. A fixed row of digits, 6 2 4 2 0 8 2 3 1 5 3 2 9 7 1, attached to the back of the

[1] The estimation of the duration is only approximate; in some cases it is reckoned from the date of admission to the hospital, and in other cases it is based upon information, more or less reliable, obtained from relatives of the patient.

frame, served as the pattern for the arrangement of the blocks, and they were to be laid in this order along the front of the frame in a space into which they fitted snugly. Before the materials were presented to the subject the movable blocks were arranged in the order 3 2 6 9 8 1 2 0 2 5 2 1 7 3 4, in a space 8 cm. farther from the subject than the space in which they were to be placed. The distance from the space at the front of the frame to the pattern at the back was 38 cm. The subject was requested to arrange the blocks as quickly as possible without making any mistakes.

It will be noted that the difficulty of this task, especially with reference to accuracy, depends largely upon the distance between the pattern and the space intended for the blocks. This test was intended to be so simple that no errors would occur, thus making speed the only variable; it proved to be so for some of the subjects, but not for all. The two rows of figures were too far apart to be compared without special accommodation of the eyes, and it was possible for certain kinds of errors, for instance, the interchange of two blocks, to escape the notice of the subject. Such errors were, however, of such rare occurrence that it has not seemed necessary to make a special study of them, but instead they have been indicated in the curves by interruptions. Other kinds of errors, for instance, the omission of a block, were sure to be discovered by the subject, but could be located only by a careful comparison of the two rows of figures. The time spent correcting such an error was usually quite considerable, and this factor is responsible for some of the deepest fluctuations which are found in the curves. It is evident, therefore, that the method was too complex for the purpose for which it was intended.

Experiment B. Maze.—A copy of the maze used in this experiment is shown in Fig. 1. The subject was given a marker with a blunt point, and was instructed to start from the circle near the center and to trace the way out without crossing a line and without raising the marker. The maze was drawn on tracing cloth, and the marker left no line which would indicate what paths had already been tried, the record of the course being obtained by placing a sheet of copying paper underneath the tracing cloth. The size of the maze was 20 by 15 cm., and the path 1 cm. in width. It is physically possible for a subject who knows the route to cover it in from fifteen to twenty seconds. Speed is the only variable considered quantitatively in this experiment.

Experiments C, C–1, and C–2. Marking Similar Figures.—Eight forms of figures were used in this experiment. Two hundred figures, twenty-five each of eight different kinds,

were arranged by chance upon a page and this chance arrangement was adopted for each of the forms, the relative position of the different figures being identical for the different forms. Form 1 contained eight digits, forms 2 and 3 consisted of 14-point capital letters, and the other forms were made up of geometrical figures. The first line of each of the forms is

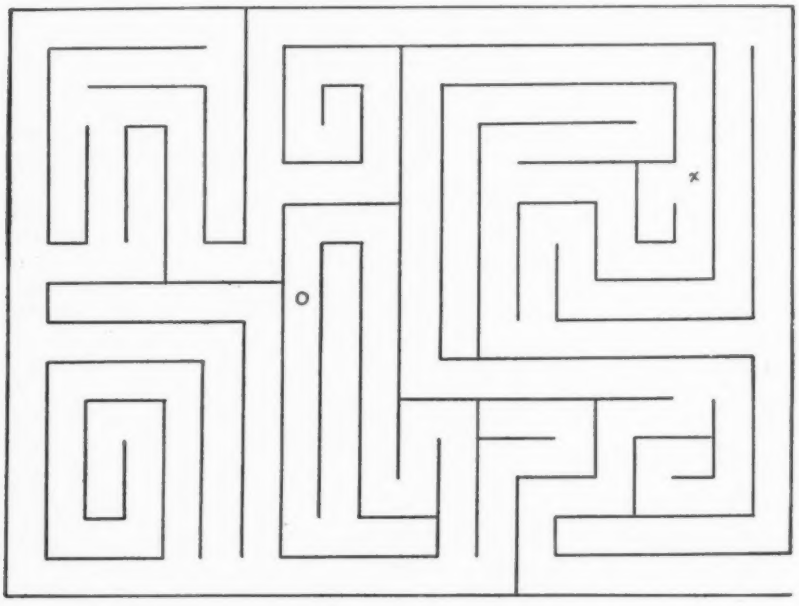


FIG. 1. Maze. Starting point indicated by circle; *x*, see text.

shown in Fig. 2, and the arrangement of the different figures in any form is shown in Fig. 3, which is a reproduction of form 1. The size of the form as printed on the page was 13 by 16 centimeters, one square centimeter being allowed for each individual figure.

The subject was instructed to go over the page as rapidly as possible, marking all the figures of a certain kind, as, for instance, the 2's in form 1, the B's in form 2, etc. At each trial a roughly drawn copy of the figure to be marked was attached to the top of the page. Some of the subjects were instructed to mark the 2's in form 1, and the corresponding figures in the other forms, while others were directed to mark

the 3's in form 1 and corresponding figures in the other forms; but for the individual subject the positions of the twenty-five figures to be marked were identical for all the different forms throughout the series.

In order to determine the skill of the subjects in finding the figures unaided by practice, a preliminary trial was given each subject with each of the forms. After this each subject was given a practice series of about sixty trials with one or another of the first three forms (Experiment *C*); then each subject was given a shorter series with one or another of the forms of geometrical figures (*C*–1); and finally, for comparison with

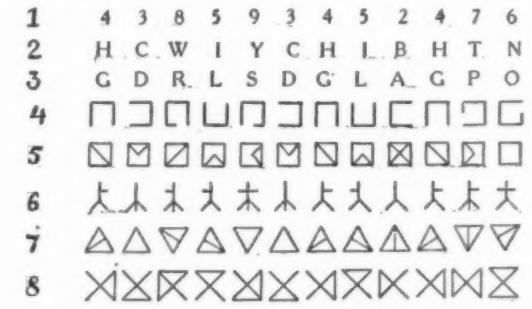


FIG. 2. First lines of the forms of figures used in experiment *C*.

the preliminary trials, each subject was given a trial with each of the forms which she had not seen during the practice series.

Three trials were regularly given at each interview, making nine trials to the week; during the last week of the practice series and for all subsequent tests, the trials were crowded more closely together, sometimes as many as twelve being given at an interview.

The subjects were instructed to take one line at a time, beginning at the top of the page, to move the pencil from left to right pointing to each figure, and to finish that line before marking any figures of the next line. Great effort was made to induce the subjects to follow these directions, but in some cases it was entirely unsuccessful; the subjects who persistently deviated from the approved mode of procedure were not excluded from the experiment, however, unless the deviation was so marked as to greatly vitiate the results.

Results. Experiment A. Rearrangement of Digits.—The results of this experiment are given in full in Table I., and are also expressed in curves in Fig. 4. Each figure in the table and each point in the curves denote the time record in seconds

4	3	8	5	9	3	4	5	2	4	7	6	
5	8	7	2	3	6	6	3	7	6	3	9	3
8	6	3	7	7	9	3	5	6	4	8	8	
9	4	6	8	9	4	7	9	7	8	4	8	9
5	9	8	5	3	2	8	6	9	8	3	9	
7	2	8	7	6	4	3	8	5	8	5	7	9
2	5	7	2	8	2	8	7	9	4	3	7	
6	2	8	3	7	9	7	5	3	5	5	6	2
7	9	4	9	2	2	4	8	4	2	3	7	
4	5	7	6	3	9	3	6	5	5	9	5	4
7	2	6	2	9	9	4	2	9	7	8	7	
2	8	3	5	6	4	7	8	7	2	4	3	8
2	6	6	5	9	4	5	8	8	3	2	4	
8	2	6	2	3	3	4	4	6	2	5	2	3
4	5	2	5	7	5	4	6	4	3	3	9	
5	9	6	2	9	5	6	6	4	9	6	6	7

FIG. 3. Order of arrangement of figures in the forms used in experiment *C*.

for an individual trial in arranging the digits. The time records of erroneous trials are indicated in the table by asterisks, but are omitted from the curves, the resulting spaces being filled in by broken lines. Any irregularities in the intervals between

trials are shown in the table by the dates,[1] but no account is taken of these in the curves.

TABLE I

EXPERIMENT *A*.—REARRANGEMENT OF FIFTEEN DIGITS. INDIVIDUAL TRIALS
Unsuccessful attempts indicated by asterisks

Subject	1	2	3	4	5	6	7	8	9	10	11
Date	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
Oct. 14, 15	130	67	138	69		163	64*	144*	120*	92*	64*
" 17, 18	100	40	110	67	48	138	73	?*	143	115	52
" 19, 20	73	50	90	114*	48	80*	61	95	130	157	59
" 21, 22	60	49	62	97	35	129	118	140*	91	170	58
" 24, 25	57	51	114	59	36	134	133	141	81	132	42
" 26, 27	56	42	81	62	27	60	55	108	109	107	41
" 28, 29	102*	49	90	115		47	70*	105	104	121	43
Oct. 31, Nov. 1	90*	36		73	44	105	115	107	88	123	44
Nov. 2, 3	45	44	74	77	42	52	62	87	94	124	44
" 4, 5	60	40	167	50	60	42	84	95	85	146	50
" 7, 8	76	40	64	68	74	107	84	84	193		49
" 9, 10	62	43	55	79	79	113	82	103	118	381*	46
" 11, 12	58	38	102	53	43	74	67	97	116	159	65
" 14	74	34	56	49	54		111	90	93	117	52
" 16	87	30	52	55	78	69	54	131	92	137	41
" 18	43	40	60	58	47	127*	83	83	114	122	52
" 21	47		57	50	115	52		102	101	161	47
" 23	71	35	49	52	85	43		169*	80	85	50
" 25	54	32	54	48	47	43	47	99	57	90	37
" 28	69	33	62	57	118	50	107	58	101	80	47
" 30	47	33	47	66	58	54	87	54	71	130	50
Dec. 2	52	33	41			59	61	61	83	120	130*
" 5	48	34	55	55				90		80	48
" 7	50	31	40	48		106	89	61			45
" 9		39	40	56			127	116			
" 12								85			
" 14						144*		44			
" 16						43		75			
" 19						63		86			
" 21						33		69			
" 26						57		52			
" 28						75		56			
" 30								178*			

Experiment B. Maze.—The time records given by seven subjects in tracing the course of the maze are shown in Table II., each number denoting the record, in seconds, of the time occupied by an individual trial. The same records, with the exception of that of subject 10, are expressed in curves in Fig.

[1] The two dates for the first thirteen trials indicate that some subjects were tested on one date and some on the other. The subjects were divided into two groups, and were interviewed some on Monday, Wednesday and Friday, and others on Tuesday, Thursday and Saturday; later in the series the two groups were combined, and after October 12 all the subjects were tested on the same days.

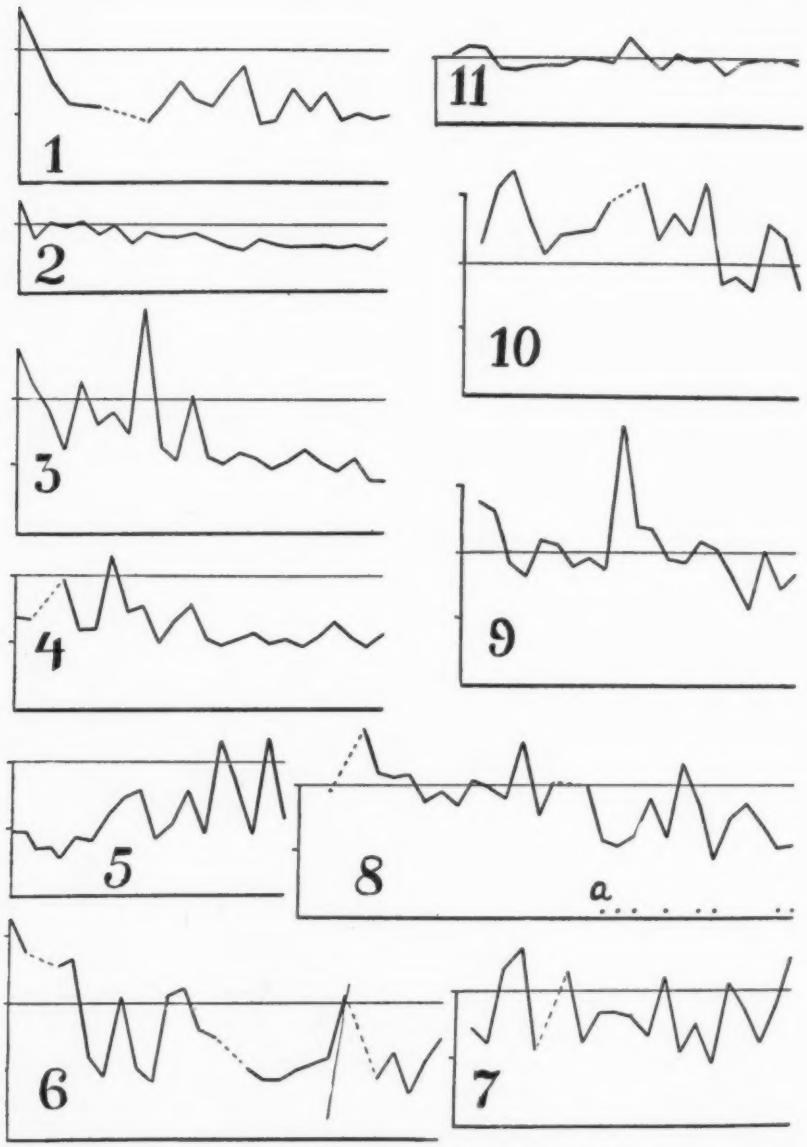


FIG. 4. Experiment *A*.—Rearrangement of fifteen digits. Time curves showing individual records. Broken lines indicate errors. Ordinate scale represents units of fifty seconds.

5. Unsuccessful attempts are indicated in the table by asterisks, and in the curves by interruptions.

TABLE II

EXPERIMENT *B*.—MAZE. TIME RECORDS OF SUCCESSFUL ATTEMPTS.
INDIVIDUAL TRIALS
Failures indicated by asterisks

Subject	1	2	3	4	5	6	10
Date	Seconds	Seconds	Seconds	Seconds	Seconds	Seconds	Sec.
Oct. 18				*	83	453	
" 19, 20	399	*	*	640	46	505	*
" 21, 22	300		795	230	42	355	
" 24, 25	210	840	840	118	34	395	810
" 26, 27	73	735	190	202	42	292	680
" 28, 29	123	370	235	139		322	750
Oct. 31, Nov. 1	50	690		104	36	130	767
Nov. 2, 3	37	344	190	124	36	467	*
" 4, 5	39	360	207	204	34	130	923
" 7, 8	44	333	121	340	29	66	
" 9, 10	38	168	79	130	48	158	
" 11, 12	31	106	117	57	31	224	1460
" 14	32	139	102	46	39		
" 16	28	145	85	51	23	369	
" 18	30	247	80	139	28	90	
" 21	18		67	42	30	362	
" 23	21	147	54	69	21	81	
" 25	27	88	57	51	14	117	
" 28	20	149	67	58	20	132	
" 30	19	97	47	47		143	
Dec. 2	22	85	47			104	
" 5			27	60			
" 7		106	49	40		111	
" 9		76	52	40			
" 12		64	50	35			
" 14			49	44		113	
" 16		67	35	72		171	
" 19			41	52		162	
" 21		78	35	35		116	
" 23		66	38	39		113	
" 26		68	40	57		68	
" 28		57		66		120	
" 30		59					

Experiment C. Marking Digits or Letters.—Table III. gives the time and error records in the marking of twenty-five characters, the letter or digit after the number of the subject indicating the character which that particular subject was required to mark. Unless otherwise indicated by figures enclosed in parentheses, each number is the average of three trials, given in quick succession; 0.3 of an error indicates, therefore, one error in three trials. All the errors which occurred in this series were omissions.

These records are expressed in curves in Fig. 6. The solid line indicates the time curve, with the scale at the left; and the dots connected by a light line represent the errors, the scale of the error curve being at the right.

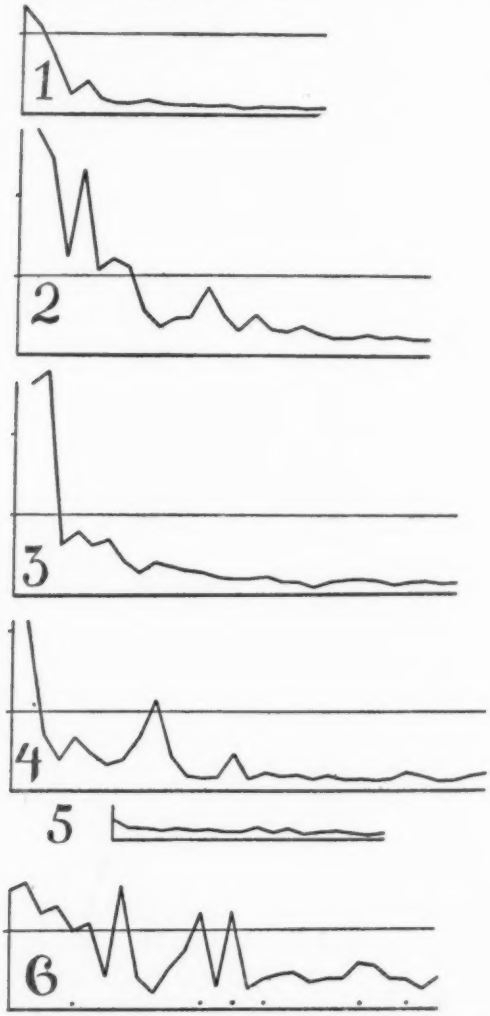


FIG. 5. Experiment *B*.—Maze. Time curves showing individual records. Ordinate scale represents units of five minutes.

The second curve of subject 1 represents a short practice series of tests with form 7. This curve will be found again in

the group to which it more properly belongs (*C*–1); it is placed here also for comparison with the first curve, of which, chronologically considered, it is a continuation.

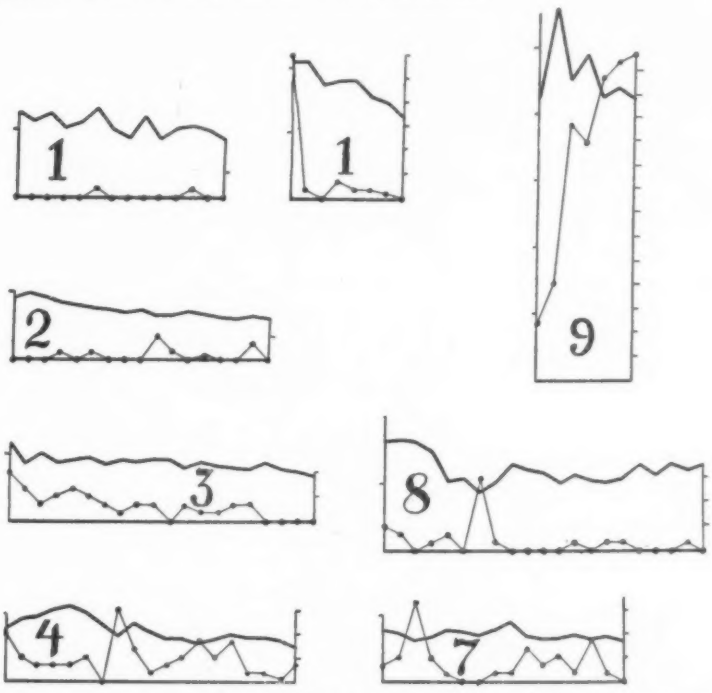


FIG. 6. Experiment *C*.—Marking digits or letters. Time and error curves showing averages of three trials. Time records represented by solid line, errors by dots. Ordinate scale at right represents units of fifty seconds; scale at left represents units of one error.

Analysis of Results. Experiment A. Rearrangement of Digits.—As has already been pointed out (p. 379), this method was favorable to wide fluctuations. The progressive tendency is somewhat obscured by these fluctuations, but the effect of practice is clearly apparent in the curves of subjects 1, 2, 3, 4, 6, 8, 9 and 10, and in the first part of the curve of subject 5.

In order to achieve the maximum of practice improvement in the performance of this task, the subject should develop, early in the series, a definite plan of using both hands. The grouping in multiples of two of the digits which are to be carried in mind is favorable to perfect coöperation between the

two hands. For example: the subject may refer to the pattern and note four digits, 6 2 4 2, take the 6 with the left hand and a 2 with the right, and place them simultaneously; the 4 may then be taken with the left hand or taken with the right and quickly passed to the left, then held while the right hand takes

TABLE III

EXPERIMENT *C*.—MARKING DIGITS OR LETTERS

Digit or letter enclosed in parentheses indicates the character marked by that particular subject. Each number represents average of three trials unless the number of trials is indicated by figures enclosed in parentheses.

Subject and Character	1 (B)			2 (3)			3 (D)			4 (A)			7 (C)			8 (2)		9 (2)	
Date	Sec.	Errors		Sec.	Errors		Sec.	Errors		Sec.	Errors		Sec.	Errors		Sec.	Errors	Sec.	Errors
Nov. 14	64	0																	
" 16	57	0																	
" 21	62	0					58	2.0		39	2.0					81	1.0	213	2.3
" 23	52	0		46	0		43	1.3		47	1.0					83	0.7	281	4.0
" 25	56	0		49	0		50	0.7		49	0.7		39	0.7		81	0	227	11.7
" 28	66	0.3		47	0		44	1.0		54	0.7		37	1.0		73	0.3	246	10.0
" 30	50	0		42	0.3		45	1.3		47	0.7		31	3.3		51	0.7	214	12.7
Dec. 2	44	0		40	0		47	1.0					34	1.0		53	0	222	13.3
" 5	60	0		38	0.3		42	0.7		50	1.0					43	3.0		
" 7	44	0		37	0		45	0.3		42	0.0		39	0.3		51	0.3		
" 9	51	0					43	0.7		33	3.0		37	0		65	0		
" 12	54	0.3		35	0		46	0.7		38	1.3					60	0		
" 14	51	0					46	0		37	0.3					58	0		
" 16	44	0		36	0		39	0.7		31	0.7					51	0		
" 19							43	0.3		32	1.0		35	0		57	0.3		
" 21				32	1.0		41	0.3		29	1.7		39	0.3		55	0	212	13.7
" 23				32	0.3		40	0.7		32	1.0		45	0.3		53	0.3		
" 26				35	0		39	0.7		35	1.7		34	1.3		54	0.3		
" 28				33	0		43	0		33	0.3		31	0.7		64	0		
" 30				31	0								32	1.0		56	0		
Jan. 2				33	0		38	0		33	0.3		34	0.3		65	0		
" 4				32	0.7		36	0	(7)	31	0.1		31	1.7		60	0.3		
" 6			(9)	30	0.1				(11)	25	0.7		33	0.3	(9)	64	0		
" 9						(9)	34	0				(12)	30	0					

a 2, so that two blocks may be placed simultaneously. The digits which are duplicated[1] in the series should be selected in a definite order; after an economical plan of accomplishing the task is decided upon, this plan should be followed con-

[1] It will be noted that the series of digits contains four 2's. This occurred by chance, and when the materials were prepared it was thought to be a trifling matter; it appears probable, however, that this fact had an appreciable effect upon the method adopted by some of the subjects.

sistently at each trial, so that the series of movements will be practically identical for different trials.

Not one of these subjects formed the habit of using both hands systematically, but each followed a more or less crude method of her own. Subjects 3 and 7 performed the task wholly with the left hand, although they were not left-handed; subjects 9, 10, and 11 used only the right hand; the others did most of the work with the right hand, but occasionally used the left for straightening the row of blocks. Subjects 1 and 11 habitually worked from right to left; the others began at the left and worked toward the right. Subject 9 memorized the digits in groups of five, reading them aloud. Subject 10, who used only the right hand, made a practice of drawing two blocks into position, so that she could place them simultaneously with two fingers; she did not lift the blocks, but even when they had to be moved a considerable distance she carefully drew them into place, pushing intervening blocks out of her way with the blocks which she was placing; in case of duplicates she selected the block which was nearest to its correct position. It was in the latter part of the series that this method was observed, and there are no notes to indicate when it was developed. Subject 8 did not develop a definite method until the series was well advanced. At first she selected, apparently at random, any block upon which her eyes fell, and placed it as accurately as she could by sighting its position as compared with the corresponding digit in the pattern, disregarding its position relative to the blocks previously placed. In this way she made many errors, and lost much time correcting them. The first nineteen records, taken as a whole, show negative results: the first successful trial occupied 95 seconds, while the first fifteen successful trials occupied, on the average, 102 seconds, the other four trials being erroneous. At the twentieth trial, which is indicated in the curve by *a*, she began at the left, and placed the blocks in the order 6, 2, 4, 2, etc. In subsequent trials she did not follow this plan consistently, but the notes show that this was the method employed at each of the trials indicated by dots along the base line. It is evident from this that all the progress which

this subject made in learning the task was made after the development of a comparatively systematic mode of procedure.

Experiment B. Maze.—In this experiment, especially in the early trials, the mode of procedure varied greatly with individuals. Some of the subjects made rapid movements, leaving the result wholly to chance, while others worked very slowly and cautiously. Inasmuch as the speed depends largely upon the number and extent of the errors, as well as upon rapidity of movement, the time record gives no indication of the method employed.

Subject 5 worked both systematically and rapidly, making such a good record at the first trial as to leave little room for practice effect. It should be noted that in respect to general intelligence and education she was at a great advantage over any other patient who served as subject in these experiments.

Subjects 1 and 3 worked at first wholly by the trial and error method, moving the marker very rapidly. Subject 2 was extremely diffident about attempting the task, and worked cautiously even after she was perfectly familiar with it. Subject 4 worked rapidly and carelessly, making many errors. Subject 6 worked by trial and error throughout the series, apparently following no plan except to leave nothing untried; she moved very rapidly, and was invariably successful, but in ability to profit by experience she was far behind the other subjects.

The records of this subject are accompanied by numerous notes, and the most significant of these are given in full; the records to which these notes refer are indicated in the curve by dots along the base line.

October 27 (fifth trial). Makes the same errors again and again, with remarkable persistency; tries out the small places faithfully, but when in a long space frequently abandons it in the middle, without looking to see where it leads.—November 16 (thirteenth trial). Knew where to start from, but appeared absolutely helpless as to direction; persistently abandoned the correct path; at one time reached the point eight centimeters from the opening, and then went back to the starting point.—November 21 (fifteenth trial). No evidence that she had any idea what was expected of her; crossed lines freely, and appeared to be trying to follow a line rather than a space; initial instructions had to be repeated. The persistence of a motor habit is very apparent in the error at the point indicated by *x* (Fig. 2, p. 380); she reaches this point many times before she attempts to find anything beyond it.—November 25 (seventeenth trial). Nearly all the time was spent in the upper right corner, where, at the point marked *x*, she repeatedly turned back as abruptly as if she had struck a line.—December 16 (twenty-third trial). No indication from her manner of working that she remembers the form, but she appears to remember what is to be done; started correctly without

instructions.—December 23 (twenty-sixth trial). At the point *A* (indicated in the record) she paused and looked, and appeared to make a definite choice between two courses; chose the incorrect one.

It is clear from these notes that what memory the subject possessed was almost wholly muscular. For a subject who was able to make so little use of past experience, on the visual side, the test was very greatly complicated by the extensive opportunities for forming incorrect habits. The persistence of a given error was the first indication that the subject was forming any habits whatever; in the latter part of the series this tendency was weakened, but was not entirely overcome. In view of the complexity of the task, regarded as a feat of muscular memory, it is significant that the subject was able to give a curve which shows a definite progressive tendency.

Experiment C. Marking Digits or Letters.—Subjects 1, 2 and 3 carefully followed the instructions to cover the page methodically, always finishing a given line before proceeding to the next. The other subjects regularly disregarded all special instructions, and their mode of procedure was regulated wholly by their inclinations. Subject 4 showed a tendency to work mainly in the middle of the page, neglecting the edges. Subject 7 habitually omitted, for a considerable time, one particular figure, but later in the series she showed a tendency to go back to this figure after finishing the rest of the page. Subject 8 gave undue attention to the neatness and uniformity of her markings, and could not be prevailed upon to make a serious attempt to work rapidly; this tendency to draw straight and even lines was observed especially in the latter part of the series. Subject 9 developed a method greatly complicated by mannerisms, and the resulting inaccuracy was so great as to defeat the end of the experiment; for this reason the series was discontinued.

On the perceptual side the possibilities of practice improvement in this experiment were somewhat narrowly limited; the finding of a familiar character, large enough to be immediately recognized and so well isolated on the page as to obviate any confusion with neighboring characters offered very little difficulty. There was more room for improvement on the motor side, and this improvement is shown most clearly in the records

of subjects 1, 2 and 3, the ones who followed the instructions. The others, because of their random methods of working, did not take full advantage of the motor possibilities.

No erroneous markings were made by any subject in this series. Theoretically it might be inferred that the accuracy would vary inversely as the speed, since any subject might, by taking time enough, perform the task correctly. Some of the records would appear to support this view, especially those of subjects 4, 7 and 8; in each of these, it will be noted, the highest point in the error curve corresponds to a point in the time curve which is lower than any previous point. But this is not the case with the curve of subject 1; and the record of subject 9, who took far more than enough time to perform the work correctly, indicates that in some cases, at least, the ratio between speed and accuracy is far from being a constant one. In view of this it has seemed better to treat the two variables separately than to employ any arbitrary method for reducing them to one.

Experiment C–1. Marking Geometrical Figures.—In the case of subject 1, for reasons which will appear later, the practice series with form 2 was brought to a premature close, and form 7 was substituted; the conditions of the tests were preserved exactly as in the first practice series.

The other subjects, at the close of the practice series with the digit or letter forms, were given short series of tests with one or another of the forms of geometrical figures, nine trials being given at a single test period.

Explanation of Table and Curves.—The results of these tests are given in Table IV. The series covered eight experimental periods with subject 1, two periods with subjects 2, 4, 7, and 8, and one period with subject 3. Erroneous markings are separated by the plus sign from errors of omission. These records are represented graphically in Fig. 7. The time curve is indicated by the solid line, and the errors by dots, no distinction being made between different kinds of errors. The interval between two serial days is indicated by a wide space, filled in by broken lines.

Analysis of Results.—It will be noted that, although these

TABLE IV

EXPERIMENT *C*–1.—MARKING GEOMETRICAL FIGURES

Each number represents average of three trials unless otherwise indicated by figures enclosed in parentheses. Erroneous markings indicated by plus sign; all other errors were omissions.

Subject	1		2		3		4		7		8	
Form	7		4		7		4		7		6	
Serial Day	Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors.
1	104	6.0	51	3.7	83	4.7	78	11.3 + 0.3	48	6.3	78	7.7
1			53	2.0	74	4.0	71	9.7	47	3.7	86	2.3
1			48	3.3	65	1.3	(2) 97	7.5	42	5.0	91	3.0
3	104	0.3	51	1.3 + 0.7			(4) 54	9.5	52	3.0	89	1.7
3			48	1.3			54	7.7	44	1.3	90	1.0
3			46	0.7			54	8.0	43	1.7	84	1.3
5	85	0										
8	89	0.7										
10	90	0.3										
12	77	0.3										
15	(12) 72	0.2										
17	62	0										

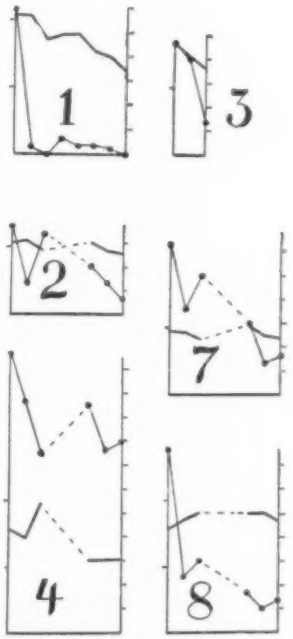


FIG. 7. Experiment *C*–1.—Marking geometrical figures. A point represents the average of three trials. Broken lines indicate interval between two serial days. Time curve represented by solid line, errors by dots. Ordinate scale at right represents units of fifty seconds, and scale at left units of one error.

series of tests were very short, each record shows a practice gain in at least one variable; subjects 1 and 3 gained both in speed and in accuracy.

Three factors combined to make perceptual discrimination more difficult for the geometrical figures than for the letters and digits: in the first place the geometrical figures possessed no clearly defined associative meaning, and no names by which they could be easily and naturally remembered; in the second place, the similarity of the eight figures of a form is much greater than that of letters or digits; and in the third place, they were printed more closely together on the page, so that an individual figure did not stand out so clearly. The difficulty of discrimination for these figures, as compared with forms 1, 2 and 3, was, therefore, very considerable. This difficulty contributed much to the possibility of practice gain.

How much of the actual practice gain can be attributed to the work of the first series could be determined only by further experiments. All that had been gained on the motor side through previous practice was at the disposal of the subjects just as early in the second series as they were able to take advantage of it. No hint was given any subject that the figures to be marked in the new form occupied the same positions on the page as the characters which she had been marking; the subjects were left to discover this for themselves, and it is not known at what stage of the series it was appreciated by them, if at all. In the case of subject 2, the first trial of this series shows a considerable gain, both in speed and accuracy, as compared with the preliminary trial with the same form (Table V.), and this would seem to indicate that the previous work was of some assistance, from the very beginning. In all other cases a comparison of the first trial of this series with the preliminary trial shows a gain in one variable and a loss in the other, which is entirely inconclusive. As the total gain in the first series was slight, the improvement in the second series must be attributed mainly to increasing perceptual familiarity with the figures. This is especially apparent from a comparison of the two curves of subject 1, Fig. 6; after all the improvement shown in the first curve is deducted from that of the second,

the remaining practice effect shown in the second curve is still very striking, especially in respect to accuracy.

Experiment C–2. Preliminary and Final Trials with Different Sets of Figures.—The results of this experiment are shown in Table V. The interval between the preliminary and final trials was about two months, and during this time the particular sets of figures under consideration had not been seen by the subject.

TABLE V

EXPERIMENT C–2.—MARKING DIGITS, LETTERS, OR GEOMETRICAL FIGURES

Preliminary and final trials with different sets of figures. Erroneous markings indicated by plus sign; all other errors are omissions.

Subject		1		2		3		4		7		8	
Form		Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors	Sec.	Errors
1		99	2			82	1			50	2		
		64	2			75	0			40	4		
2				70	0	62	1	47	0			83	1
				34	1	55	0	34	1			103	0
3		76	3	62	0					87	2	78	5
		47	2	43	0					85	2	107	0
4		85	16	157	2	117	3	140	5+1	122	7	120	10+1
		104	6	65	1	79	1	76	15	76	6	117	8
5		83	2	109	0	129	3			117	5	113	8
		56	2	71	0	74	1			92	1	103	0
6		82	5	136	1	126	1+25	70	5+1	200	7+13	99	4
		108	1	89	1	119	2	64	4	107	1	82	10
7		91	14	125	0	102	4+1			87	3	108	9
		103	6	58	0	112	1			57	6	148	2
8		128	11	132	0	105	4			85	13	142	7
		118	6+1	76	0	104	0			60	7	177	0

The effects of practice transfer may be noted by comparing the preliminary with the final records. There are in all thirty-eight cases of such comparison. Fourteen of these show a gain in speed with a loss in accuracy, and eight show a gain in accuracy with a loss in speed; it is not possible in these cases to balance the gain and loss, but it is noteworthy that sixteen cases show an improvement in both speed and accuracy, while in no case is there a loss in respect to both variables. It is obvious, however, that the gain may have been due in part to general adaptation, as well as to practice transfer.

Notes on Individual Cases.—Subject 1 (see also p. 378). At first this subject showed considerable interest in the experiments, but her attitude toward them was gradually changed when she was transferred to the ward in which the tests were con-

ducted, a less desirable ward than the one which she was required to leave. For a day or two she cried almost constantly, and begged to be excused from the tests. The first interruption in a curve of almost mathematical neatness occurred at this time. (See Fig. 4.) After a week or two the patient adapted herself to the ward, but her interest in the experiments were lost, and throughout the series her coöperation was variable. At the time when experiment *C* was commenced she was in a favorable mood, and showed much interest in the preliminary tests. In the practice series, in which she was required to mark the letter B, she coöperated very reluctantly. The reason for this unwillingness was revealed when the series was well advanced: the subject's mother's name began with B, and she was afraid that the crossing out of the B's would work some injury to her mother. Because of this disturbing factor, the series was brought to a close. The subject was then given a series of trials with form 7, and in this she coöperated better.

Subjects 2 and 3 (p. 378). These subjects gave exceptionally good coöperation in all three experiments, and obeyed with great care all instructions.

Subject 4 (p. 378). An efficient worker in work which calls for large movements, but awkward and erratic in the performance of work which requires care and skill. Extremely inattentive, and frequently paused in the middle of a test to ask irrelevant questions. In marking figures she could not be induced to cover the page systematically.

Subject 5 (p. 378). This patient appeared, at the time of the first interview, to be the most promising subject of the group; but after about two weeks she became disturbed, and grew rapidly worse, until, finally, the tests had to be discontinued. Her time records for the arrangement of the blocks were greatly disturbed by mannerisms; sometimes after placing a block correctly she picked it up, shook it violently, and then replaced it. The effect of such performances is clearly apparent in the fluctuations of the time curve (Fig. 4). She gave much better coöperation in the maze test (Fig. 5); this task was much too easy for a person of her intelligence.

Subject 6 (p. 378). Coöperated willingly, but did not readily comprehend the instructions. Her mode of procedure with the maze has been described above, p. 390. The marked motor tendencies observed in connection with that experiment were apparent also in her procedure with the blocks. At the first trial, because of the great difficulty of making the requirements clear to her, she was permitted to deviate from the plan of the test, and to place the blocks in a space of her own choosing instead of in the space intended for them; this was not permitted again, but the tendency to follow this plan persisted throughout the series. Frequently she appeared to have no idea what was expected of her; at the last trial of the series she started to arrange the blocks indiscriminately, without referring to the pattern, and the object of the test had to be explained as carefully as at the first trial. Only the preliminary tests of experiment *C* were undertaken with this patient. In marking the geometrical figures she gave very little attention to the figure attached to the top of the page, but marked one figure or another, almost indiscriminately. As she finished form 7 (triangles), her attention was called to the figure which she had just marked and she was asked if it were like the one at the top of the page; she replied "It's almost like it—it's a triangle."

Subject 7 (p. 378). Coöperation variable; in the latter part of the series it was extremely difficult to induce her to take part in the experiments; she frequently refused to come to the room, but if brought by the nurse and forced to take her seat she invariably performed the tasks. All attempts to influence her mode of procedure were entirely unsuccessful. Neither of the time curves given by this patient shows any appreciable progressive tendency (Figs. 4 and 6).

Subject 8 (p. 378). This subject coöperated well within certain limits, but she usually ignored any instructions concerning the mode of procedure. As has been noted above (p. 389), her method of arranging the blocks was not developed until late in the series. The experiment was brought to a close by the persistent tendency on the part of the subject to make errors, apparently by intention. No explanation could be obtained. She refused to try the maze. In marking the figures she was attentive to the work, but could not be induced to follow any definite plan of covering the page. She took the greatest care to mark the figures in a certain precise way. She was repeatedly assured that a careless mark would serve the purpose better, because it would require less time; but she showed an increased tendency, especially in the latter part of the series, to give undue attention to the length and direction of each mark.

Subject 9 (p. 378). Coöperation extremely variable. Insisted that the condition of the experiments should be absolutely uniform from day to day, and resented the slightest deviation from the programme. In marking the figures she developed a mannerism which soon became a habit: she made circular movements with the pencil about each figure that was to be marked. At first these circles which she described in the air were just large enough to include the figure, but their size gradually increased until they almost covered the page; as the subject's eyes followed the pencil, she lost sight of the figure which she had spotted to mark long before she was ready to mark it. (See Fig. 6.) All attempts to obtain better coöperation were entirely unsuccessful, and the series was discontinued. The subject did not wish to be dismissed, and later, at her request, she was given another trial; as the mannerism still persisted, no further notice was taken of her requests.

Subject 10 (p. 378). Complied slowly and mechanically with every request. Her mode of arranging the blocks has been described above (p. 389). She performed the maze test successfully a few times, apparently by chance. The time records are given in Table II., but are not expressed in a curve. The subject made the same errors repeatedly. On one occasion after reaching the opening she placed the marker inside again, and went on moving it as before. Her movements did not appear to be directed toward any end, and it was impossible to determine how clearly, if at all, she recognized the opening as the goal to be reached.

Subject 11 (p. 378). At first gave very good coöperation, evidently hoping that the results would prove her to be in good mental health. Gradually, as she began to realize that this was not the purpose of the experiment, she lost her interest in it. Became inattentive, and persisted in talking during the tests. In the latter part of the series it was observed that after placing a few blocks she frequently paused to feel of them, as if to be sure that they were neatly placed, although no readjustment of them was needed.

3. *Second Series*

The seven patients who served as subjects in the second series of experiments were well advanced cases, and were selected as being some of the most hopelessly demented patients who could, with safety to the experimenter, be employed in the experiments. The following notes are taken from the case histories:

Subject 12. Age nineteen. Duration four years. Destructive, untidy.

Subject 13. Age fifty-eight. Duration thirty years.

Subject 14. Age forty. Duration ten years. Noisy, destructive, violent, untidy.

Subject 15. Age twenty-six. Duration five years.

Subject 16. Age forty-five. Duration fourteen years. Noisy, destructive, untidy.

Subject 17. Age thirty-one. Duration eleven years. Noisy, destructive, violent, untidy.

Subject 18. Age thirty-nine. Duration seven years. Idle, indifferent to surroundings, noisy, profane, destructive.

Considerable preliminary experimentation was necessary in order to devise methods adapted to the ability of these subjects. It was only by frequent repetition that any command could be so forced upon their notice as to meet with any response, and even after the performance of a task was fairly started, their attention could be held to it only by constant urging and encouragement. It was essential, therefore, that the task should be extremely simple and short, and that the instructions could be given in a few words.

Description of Methods. Experiment D. Placing Twenty Pegs in Holes.—A kindergarten peg-board and a box of pegs were used in this experiment. The board was a piece of wood six inches square with one hundred holes drilled to a depth of about four millimeters. The greater part of the board was covered, leaving exposed twenty holes, in two rows of ten each, neighboring holes being one half inch apart. The pegs fitted so loosely into the holes that some care was required to keep them from being accidentally displaced. More than twenty pegs were provided. The records consisted wholly of the time occupied by the task. Two trials were given at an interview, making six to the week.

Experiment E. Rearrangement of Ten Blocks. This was a greatly simplified form of experiment *A*. The materials consisted of ten toy blocks 45 mm. square and 17 mm. in thickness, and a wooden frame large enough to hold, with a margin of five millimeters each way, twenty of these blocks in two rows. The blocks were differentiated from one another by squares of colored paper,[1] 29 mm. square, which were pasted diagonally

[1] The following colors of the Milton Bradley Kindergarten papers were used: (1) red, shade No. 1; (2) orange red, tint No. 2; (3) orange, shade No. 1; (4) orange yellow, tint No. 1; (5) yellow, shade No. 1; (6) yellow green; (7) green, shade No. 1; (8) green blue, tint No. 1; (9) blue, shade No. 1; (10) violet, shade No. 2. These colors were easily distinguishable, as was shown by preliminary tests.

upon them. A row of imitation blocks along the front of the frame furnished the pattern for the arrangement of the blocks, the order of colors in the pattern being 5, 9, 4, 3, 7, 8, 10, 1, 2, 6. Before each test the movable blocks were arranged at the back of the frame in the order 1, 3, 8, 5, 10, 2, 4, 7, 6, 9, and the subject was instructed to move each block to the space immediately back of the similar color in the row of imitation blocks at the front. Two trials were given at an interview, but they were separated by a trial with the twenty pegs.

Errors were not permitted in this experiment, and the time occupied by the task constituted the only recorded variable. On rare occasions an error was made, but the time was not registered until it was corrected; the subject's attention was called to the error, if necessary, by the warning to be careful, but she was given no assistance in locating it.

Other Methods.—The interviews with these patients afforded favorable opportunities for experimentation by various methods, not primarily for the purpose of obtaining additional data for this study but rather with a view to testing the methods.

The mage was used irregularly with some of the subjects. Another experiment was a very simple picture puzzle, made by cutting a picture postal card, mounted on stiff cardboard, into eight approximately square pieces. If a subject failed, after a reasonable time, to put the pieces together correctly, she was given a little assistance and was then allowed another trial. These patients were also given a little work in plain sewing: the hem of a towel was basted, and the work was started for the subject with thread of a given length. A definite amount was marked off as a day's work, and the subject was requested to sew as rapidly as possible; the stop watch was held under cover, so that she would know that the time was recorded. The stitches were afterwards counted. The principal objection to this, as an experimental method, is that the quality of the work cannot be expressed quantitatively. In order to obtain definite results it would be necessary to try the method on a much larger scale, expressing the results not in terms of the number of stitches taken in a minute, but in terms of the number of towels satisfactorily hemmed in a day.

Results. Explanation of Tables and Curves.—The results of experiments *D* and *E* are given in Tables VI. and VII., respectively. All numbers except those designated by asterisks represent averages of two trials. As the same subjects took part in both experiments, the two sets of time curves are given in parallel columns, in Fig. 8.

Analysis of Results. Experiment D. Placing Twenty Pegs in Holes.—The effect of practice is well marked in the curves of subjects 12 and 13, and is appreciable in those of subjects 14

TABLE VI

EXPERIMENT *D*.—PLACING TWENTY PEGS IN HOLES

Asterisks indicate records of individual trials; all other numbers represent averages of two trials.

Subject	12	13	14	15	16	17	18
Date	Seconds	Seconds	Seconds	Seconds	Seconds	Seconds	Seconds
Nov. 26	127*	144*	73*	94*	70*	57*	55*
Dec. 1	112*	137*	77*	60*	88*	70*	51*
" 3	100	103	78	66	69	66	44
" 6	92	94	60	92	58	60	40
" 8	109	92	65	65	75	63	42
" 10	92	89	67	54	65	58	44
" 13	91	102	47	69	82	50	46
" 15	83	74	66	62	83	66	50
" 17	90	100	62	63	69	57	49
" 20	96	96	58	59	71	68	58
" 22	79	91	55	65	58	61	47
" 24	91	95	54	58		61	49
" 27	92	86	80	61		58	45
" 29		86	61	169		57	
" 31	91	79	54	132		56	47
Jan. 3	79	99	64	167*		54	48
" 5	76	123	58			61*	41
" 7	70	102	53				51*

TABLE VII

EXPERIMENT *E*.—REARRANGEMENT OF TEN BLOCKS

Asterisks indicate records of individual trials; all other numbers represent averages of two trials.

Subject	12	13	14	15	16	17	18
Date	Seconds	Seconds	Seconds	Seconds	Seconds	Seconds	Seconds
Dec. 3		127			62		42
" 6		96	123	120	45		28
" 8		76	93	36	40	156	25
" 10		62	79	31	37	66	35
" 13		85	36	31	38	46	20
" 15		64	53	32	35	85	28
" 17		71	49	32	28	70	24
" 20		70	47	27	36	92	25
" 22		79	42	29	30	66	19
" 24		76	35	27		67	24
" 27		64	58	29		61	23
" 29		60	44	103		78	
" 31		63	35	75		56	32
Jan. 3		57	50			65	23
" 5	151	71	52			44*	21
" 7	81	92	34*				
" 12	58		43*				
" 14	53						

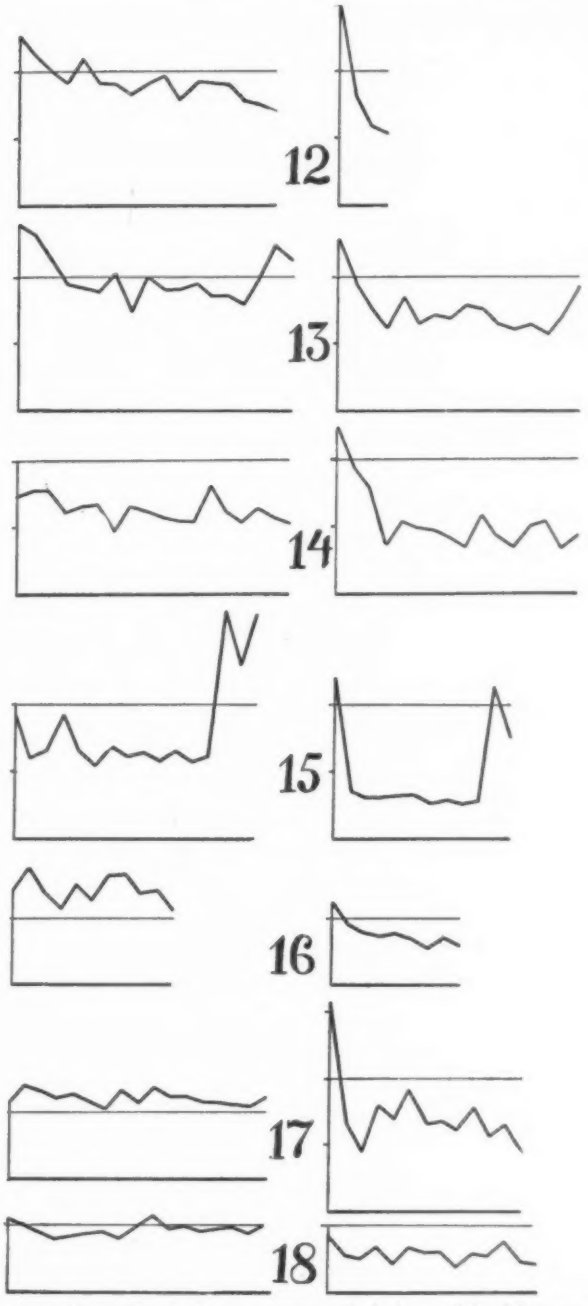


Fig. 8. Experiment *D*, placing twenty pegs in holes, at left of figure; experiment *E*, rearrangement of ten blocks, at right of figure. In both sets of curves the points represent the averages of two trials. Ordinate scale represents units of fifty seconds.

and 15; the other curves are characterized by fluctuations rather than by progressive tendencies.

In this experiment there was comparatively little to be learned which depended upon perception. The general feeling of the pegs, their size relative to the holes, the depth of the holes, and the ease with which the pegs which had been placed could be dislodged—such factors as these could be learned during the first few trials. The possibility of a considerable practice effect depended largely upon the development of a definite method of procedure. The most economical method for the writer, as tested by over fifty trials, is to lay a pile of more than twenty pegs back of the two rows of holes and to work coördinately with both hands, filling first the farther and then the nearer row of holes, and in each case beginning at the left of the row. Another normal observer attained to his greatest speed in a series of ten trials by picking up the pegs with the left hand and passing them to the right, placing them with the right hand, beginning at the left of the board, and carrying the two rows along together. It does not seem probable, therefore, that the same method would serve best for all subjects, but for any subject there is necessarily some method which, if followed consistently, would give better results than could be obtained by random work.

The patients showed no clearly defined tendency to develop a definite method of performing this task. In the early part of the series, it was observed that subject 18 emptied the pegs from the box into the left hand and held them within easy reach of the right hand; but she did not follow this plan consistently, and later in the series worked less systematically. The other subjects usually took the pegs from the box one at a time, taking no care to place the box near the board.

Without the formation of a definite habit of working, the possibilities of practice effect in this task were somewhat narrowly limited; but there was in all cases much room for improvement in respect to attention, and in some cases in respect to the subject's willingness to comply with the conditions of the test.

Experiment E.—All the curves except that of subject 18

show a clearly defined progressive improvement during at least a part of the series.

In this experiment there was considerable to be gained by remembering the position of each block in each of the two series; perceptual familiarity with the materials was easily acquired, and the rapid increase in speed during the first few trials may be attributed largely to this factor. On the motor side also this experiment was more favorable to practice effect than was experiment *D*, for the reason that the movements which constituted the task were more strictly limited. The conditions required that each block be moved from a certain place to a certain place, and although some of the subjects showed a tendency to pick up a block and examine it thoroughly before placing it, still there was a fair probability that the frequently repeated instructions would receive a little attention, and that some of the blocks would be carried directly from one place to the other.

The important matter of deciding in what order the blocks should be moved was left to the caprice of the subjects.

The method which most naturally suggests itself to the subject is to follow the order of the colors in which they occur, either in the pattern or in the row of blocks as they are found. There is an essential advantage in following the order of the fixed series rather than that of the movable series. If the blocks are selected in the order in which they are found (1, 3, 8, 5, etc., or, beginning at the right, 6, 2, 1, 10, etc.; see page 399), either the first blocks must be laid accurately, with some care, or else it will be found necessary later to make occasional readjustments in order to make room for the blocks which are placed last. On the other hand, if the order of the fixed series is followed (5, 9, 4, 3, etc., or 6, 2, 1, 10, etc.), the placing of each block pushes all the previously placed blocks toward the end of the frame, and they are, without conscious effort on the part of the subject, fitted so closely together as to allow ample space for the last blocks.

While the selection of the blocks in the order of the colors found in the pattern is probably the best method which would occur offhand to a subject, experience shows that this method may be considerably improved by taking advantage of certain short-cuts which permit two blocks to be placed simultaneously.

This series of tests was not continued long enough to allow the subjects to perfect their methods if they had been disposed to work methodically; there was, however, only one subject who, at the close of the series, appeared to have made a fair beginning toward the development of a method. Subject 15, during her period of best coöperation, worked from the left

of the pattern to the right, very carefully and systematically, reaching unerringly for the block which she wanted. She worked at a comfortable rate, and made no apparent effort either to increase her speed or to improve her method. (See Fig. 8; for explanation of the rise in the curve near the close of the series, see p. 405.)

No other subject was observed to follow the order of the colors in the pattern. Some took the blocks in the order in which they found them, and some selected them wholly at random.

For some unknown reason, it was more difficult to secure the coöperation of these patients in experiment *E* than in experiment *D*. No subject on any occasion positively and finally refused to place the pegs in the holes, while only three of them, subjects 13, 16 and 18, could at the first attempt be induced to arrange the blocks.

Notes on Individual Cases.—Subject 12. (See also p. 397.) This was the most difficult and unpromising subject with whom the experiments were attempted. At the first trials she seated herself at the table only under compulsion, and it was difficult to prevent her from removing her clothing and pulling out her hair. Every command had to be forced upon her attention by many repetitions. It was only by the most persistent nagging that she could be induced to place the pegs in the holes, but the attempt to obtain a record of this experiment was in no instance abandoned without success. On the other hand, all efforts to induce her to arrange the blocks regularly failed during the first twelve interviews. At the thirteenth interview the blocks were not offered, but instead a puzzle picture of eight pieces was presented; this immediately attracted her attention, and from that moment her attitude toward the experiments was completely transformed. For twelve minutes she worked eagerly at the puzzle, but without making any apparent progress; she occasionally fitted two pieces together correctly, but soon took them apart to try something else. She did not recognize the narrow white border as belonging to the edges of the picture, and there was nothing in her manner of working to indicate that she would succeed by trial and error. She was therefore given some assistance, and was then allowed another trial; she was successful at this and at all subsequent attempts with this puzzle, but did not succeed unassisted with any other simple puzzle which was subsequently offered. At the interview following the first presentation of the puzzle, experiment *E*, the materials of which she had many times refused to touch, was again tried. She willingly, but very awkwardly, arranged the blocks. About a week later all experimentation upon this group of subjects was discontinued, and this subject received only eight trials with the blocks; this series was long enough, however, to show strikingly the effects of practice (Fig. 8). During the last week of observation the subject was given various other tasks, most of them entirely beyond her capacity. She invariably made all possible effort to follow the instructions, and did not once abandon the attempt until required to do so.

Subject 13 (p. 398). It was impossible to hold this subject's attention for any considerable length of time. She showed an irresistible tendency to play with the ma-

terials, and required to be frequently reminded what she was expected to do with them. Her condition was variable; during the last week of observation she was excitable and suspicious.

Subject 14 (p. 398). A very troubleseome patient, because of her great psychomotor activity. The following notes are found in the case history, under different dates: "The conduct of this patient is impulsive. She rushes up and down the ward, jumps over chairs, etc. Her movements are all more or less purposeless; she pushes first one patient and then another out of her way, and continues in this restless manner throughout the day. She disarranges her hair and clothing, and presents an untidy appearance. . . . Makes unprovoked assaults on patients; these appear to be more playful than malicious. . . . Is destructive to her clothing, and to furniture and plants on the ward. . . . Patient does no work, is noisy, destructive, violent, untidy." In the experiments her attention was easily gained, but it was only by repeated commands that she could be induced to perform the tasks. She entered the room in a noisy and disorderly manner, and handled the materials roughly, but did not injure them. At the fifth trial with the blocks she intentionally made an error, but finally, in response to a command, she corrected it. When given a towel which was to be hemmed, she took it with many accessory movements, but after the work was fairly started she sewed well and carefully. There was a progressive, although fluctuating, improvement in her coöperation. The maze and the picture puzzle were added to her tasks; she did not succeed with either by trial and error, but was easily taught to perform the tasks. At the eighteenth interview experiments *D* and *E* were omitted, and the maze was presented first. On this day the subject was somewhat excited, and her conduct was more disorderly than usual. She did not frankly refuse to try the maze, but she disregarded all the rules of the test, becoming more troublesome as the minutes passed. The materials were then quietly withdrawn, and the peg board and blocks were presented in the usual order; in these tests she coöperated well, and all accessory movements soon subsided. After those tests she was given a piece of fine sewing, and worked well; when dismissed she left the room in a quiet and orderly manner. It appeared from this that simple and mechanical activities tended to furnish an outlet for the habitual motor restlessness of this patient. She apparently lacked either the intelligence or the interest to undertake tasks which called for voluntary attention, but was willing to perform tasks which could be done mechanically. At the next interview she was invited to remain in the room and hem towels during the tests upon the other patients; she worked well, and did not in any way disturb the tests. The next day, as an experiment, she was sent to the sewing-room, and she has ever since been regularly employed there. At the date of the present writing (six months later) she is reported as being industrious and well behaved.

Subject 15 (p. 398). Conditions variable; at times orderly and industrious, and at other times extremely destructive and violent. (Diagnosed on admission as a case of manic-depressive insanity, but is now considered a clear case of dementia præcox.) At the time when the experiments were commenced, according to the statement of the nurse, she was becoming quiet after a disturbed period. During the first week her coöperation improved with each interview, then for three weeks she was very attentive to the tasks, requiring no instructions nor urging. She was successful in performing the maze experiment; she worked with care and foresight, and made few errors, but did not appear to make any serious effort at speed. The last three records in experiment *D* and the last two in experiment *E* were obtained when the patient was passing into a disturbed condition. At the last three interviews she was extremely troublesome, and it became impossible to continue the series further.

Subject 16 (p. 398). Very troublesome at first, after which, for about two weeks, she appeared to take the tests quite as a matter of course. Later she refused to come to the room, and the series had to be discontinued.

Subject 17 (p. 398). Talked constantly during the interviews. It was difficult to force any command on her attention, but if she could be induced to make a single movement toward complying, she usually performed the task without a pause, talking incoherently all the time.

Subject 18 (p. 398). Motor reactions very prompt; always willing to do anything that was asked of her. Attention difficult to hold; while arranging the blocks she talked constantly about various things suggested by the colors of the blocks, but she worked so rapidly, in spite of her apparent inattention, that it was difficult to observe her method. She sewed very poorly, taking very long stitches, about four or five to the inch. She was successful with the maze; two trials were given daily, and for this reason the results are not comparable with those of the other group of subjects. Six times out of ten the second trial on a given day occupied a longer time than the first. Her success appears to have been due to rapidity of movement, and there is no indication that the fluctuations were determined by any other factor than chance. None of the results obtained from this patient show evidence of practice improvement, and the negative results cannot in this case be attributed to lack of coöperation. The tests were too simple on the surface, for a subject whose motor mechanism was so alert, while in reality they were too complex for a patient of her intelligence. There was, apparently, no difficulty to be overcome which was capable of overcoming.

General Considerations

Casual Observations of Habit Formation.—The readiness with which these patients adapted themselves to the requirements of the experiments furnishes an illustration of the production of habits too complex for exact study. Gatewood[1] has called attention to the persistence in a dement of a habit accidentally formed, even so unnatural a habit as the regular use of the feeding tube. These observations also show the tendency of a habit once formed to persist; two of these subjects (5 and 9) formed accessory habits in connection with the performance of the tasks, and these habits were not overcome. Of greater significance, however, for this study, is the ease with which a new habit may be established, provided it does not come into direct competition with an already existing habit of action.

All the patients gave better coöperation and attention during the second week of the series than during the first week; all complaints and all questions concerning the purpose of the tests tended to diminish, and each of the subjects, for at least

[1] Gatewood, L. C., 'An Experimental Study of Dementia Præcox,' *Psych. Rev. Monograph*, 1909, No. 45, Vol. XI.

a short period, appeared to regard the tests as a part of the regular hospital routine. With ten of the subjects this attitude prevailed throughout the series; subjects 1, 5, 7 and 8 became less disposed, as the series progressed, to submit to the requirements, but they continued, however reluctantly, to perform the tasks. The first attempt to secure a patient's coöperation in a given task was very frequently abandoned as a failure, but only four times throughout the series did any subject refuse to perform a task which she had once performed (subjects 14, 15, 16 and one patient not included among the eighteen).

It should be noted, however, that the efforts of the experimenter to secure coöperation were more obstinately persistent when the success of a series already in progress was at stake than when it was merely a question of deciding whether or not to undertake a new series with a particular patient.

During the first two weeks of the experiments with the first group of subjects, several of them were regularly brought from another ward to the ward in which the tests were conducted, and while waiting for their turn they occupied a seat in the corridor, just outside the door of the experimenting room. Later these patients were transferred to this ward, and for several days they could with difficulty be induced to leave that seat; even subject 1, who was considerably disturbed by the change, remained in that part of the corridor for some days, and was regularly found there waiting for her turn.

Several subjects showed a tendency to resent the most trifling deviations from the routine of the test period, such as a change in the order in which different tests were presented. Subject 4 was greatly displeased when she was called away from her daily work of scrubbing the floor. Subject 2 was considerably disconcerted by the request to perform the tasks in an unaccustomed place. On one occasion, subject 9 was called to the experimenting room ahead of the patient who had preceded her at the last few interviews; she protested that it was not her turn, and when asked what difference it made replied that everything should be done in order. Another time she said, "I can't take my lesson today, because I didn't have my bath this morning; the bath has to come first." She was with difficulty persuaded to perform the tasks, and gave a very poor

record. Both this patient and also subject 3 were displeased when the experiments were discontinued.

In view of the difficulty of controlling minutely the conditions of the daily occupation of patients, excessively servile subjection to routine is not to be encouraged. But just as some children submit more cheerfully to the regulations of the clock than to arbitrarily imposed decrees, so some patients can be governed with the minimum of friction by taking advantage of their respect for order and precedent. The tendency of a patient to demand strict uniformity in the regulation of his daily life is a factor which may well be taken into consideration in connection with any attempt to determine for what occupation the individual patient is best fitted.

Methods of Learning.—With a few exceptions, these subjects made extremely hard work of their light tasks. Their mode of procedure presents a striking contrast to that of Swift's subjects who practised tossing and catching balls. Swift observes:[1] "It is interesting that all the subjects improved by hitting upon better ways of working without any further selection, at first, than the general effort to succeed. There seems to be a competition of methods. . . . Consciousness discovers modes of action already in use and selects some of them for survival because of their success. They then pass into the automatic." This competition of methods was but barely observed among the subjects of these experiments; in many cases the method which chanced to be used at the first trial was followed in all subsequent trials, no attempt being made by the subject to discover a better method. Not one of these subjects discovered, by the trial and error method, the easiest way of performing a simple and obviously possible task, and the experiments were characterized throughout by a high percentage of needless labor. Even in tracing the course of the maze—the experiment which placed the highest premium upon the exercise of judgment—only two of the eight subjects (5 and 15) showed the least tendency, at the first trial, to work rationally, the others working wholly by random methods. It cannot be assumed, how-

[1] Swift, E. J., 'Studies in the Psychology and Physiology of Learning,' *Amer. Jour. Psych.*, 1903, XIV., p. 216.

ever, that an absurdly unsystematic method of performing a simple act is characteristic of mental disease; it may be accaccounted for in part by other factors, such as general intelligence, occupation, and sex.

Some patients who readily accept instructions concerning what is to be accomplished persistently reject all directions or suggestions as to how it is be to accomplished. To induce such patients to follow a given method is a special problem. In this study all attempts to hurry a patient who was naturally inclined to be slow and all attempts to induce a careless person to do accurate work were entirely unsuccessful, and the question as to the possibilities of systematic training remains for further investigation.

It is of special significance that some of the most clearly defined practice effects shown by these results were obtained from patients who were at least forty years of age (subjects 2, 3, 4, 13, 14 and 16).

The methods employed in this study were more favorable to improvement in perceptual discrimination than to the establishment of definite habits of action. In spite of this fact, however, unmistakable practice effects were obtained from a subject whose memory for the experiments appeared to be almost wholly muscular (subject 6, Figs. 4 and 5).

Conclusions

Definite practice effects can be obtained, by means of a short series of tests, from advanced cases of dementia præcox.

The willingness of the subject to coöperate constitutes an important variable. The means employed for obtaining the coöperation of insane subjects must be adapted, to some extent, to the individual.

The importance of giving a patient special training as to the proper method of performing a given task is clearly indicated by the failure of these subjects to devise economical methods.

Practice effect gained in one kind of work appears to be to some extent transferable to another kind of work which differs from the first in its perceptual, but not in its motor aspects.

In any attempt to establish a new habit in a patient, it is well to take advantage, as far as possible, of habits already present.

There are indications that some of the energy ordinarily expended in mischievous performances may, by careful training, be directed into more favorable channels (subject 14). These findings offer some promise that results of practical value, both economic and therapeutic, may be obtained by an extension of this investigation.

SUPPRESSION WITH NEGATIVE INSTRUCTION[1]

BY H. S. LANGFELD

Tests with Alcohol and Caffeine and on Cases of Dementia Præcox and Manic Depression

In a previous article[2] the nature and development of the act of suppression with negative instruction in association tests under normal conditions are described. The object of this paper is to give the effect of alcohol and caffeine upon the power of association and reproduction as well as upon the act of suppression. Introspective data upon the process of suppression is also included. The results of the association tests with suppression in cases of dementia præcox and manic depression will also be briefly described at the close of the paper. The same conditions as in the previous experiment prevailed for these experiments. Simple pictures representing a single object were shown and the subject told to give the first word suggested by the picture. As two of the subjects figured in both series new pictures, but of the same nature as the others, were used, except in the case of the tests on the insane, where the old pictures were employed. In all 120 pictures were used, 10 of which were shown on each test day. With few exceptions a test was made every week. The previous instructions were altered so that the subjects were told not only not to name the picture, but not to name any part of it. This was found necessary because one of the subjects got 'set' to name a part of the picture. Except in the case of the insane subjects full introspection on the main period was required at all times. After the experiment had been some weeks in progress Professor Titchener's suggestion[3] in regard to introspection upon the fore-period was followed. The reaction time was taken with a

[1] From the Harvard Psychological Laboratory.

[2] 'Suppression with Negative Instruction,' *Psychological Bulletin*, June, 1910, Vol. VII., pp. 200–208.

[3] E. B. Titchener, 'A Text-Book of Psychology,' p. 460.

TABLE I

TESTS WITH ALCOHOL

Subject A

Al = alcohol test, N = normal test, A = association test, R = reproduction test, R.T. = reaction time, k′ = any kinæsthetic imagery, k″ = kinæsthetic imagery of the name of the picture, v = visual imagery, a = auditory imagery, S.S. = successful suppression, S.R. = successful repetition.

	No.	A		R		A				R				A	R
		R.T.	m.v.	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	1.7	.30	1.7	.16	4	2	6		2	1	2		10	8
Al	2	1.6	.36	1.3	.16	5	2	4				1		9	8
N[1]	3	1.2	.09	1.0	.13	3	1	6		4		6		9	7
Al	4	1.1	.15	1.1	.10	10	4	5		6	3	7		8	10
N	5	1.7	.58	1.3	.16	6	3	6		4	1	3		8	9
Al	6	1.5	.24	1.1	.10	6	2	11				7		10	9
N	7	1.6	.16	1.5	.20	5	1	14		3	2	6		10	9
Al	8	1.3	.16	1.2	.10	9	4	5		1	1	1		9	8
N	9	1.6	.14	1.3	.28	15	3	8	1	3		2		10	6
Al	10	1.4	.46	1.1	.16	4	1	2		1	1	1		10	9
N	11	1.5	.21	1.3	.18	9	4	2		3	1			10	9
Al	12	1.3	.27	1.0	.20	5	3	1		4	3			9	10
N	av.	1.5	.24	1.3	.19	Total 42	14	42		19	5	19		% of un-	3%	18%
Al	av.	1.4	.27	1.1	.14	Total 39	16	28		12	8	17		successful tests	8%	10%

[1] Contains only nine reactions.

Subject B

	No.	A		R		A				R				A	R
		R.T.	m.v.	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	1.8	.40	2.4	1.30	15	10	1		7	4			10	8
Al	2	1.7	.26	1.6	.40	16	11	3		15	8	1		7	8
N	3	1.6	.11	2.0	.19	10	6	2		10	7	1	1	9	7
Al	4	1.6	.15	1.5	.37	16	11	1	1	6	5			9	6
N	5	2.0	.72	1.8	.33	10	7	2	1	9	6			8	6
Al	6	1.4	.18	1.1	.22	4	4		4	3	3	2		10	9
N	7	1.7	.36	1.5	.46	13	11	3		6	3			9	8
Al	8	1.9	.44	1.4	.28	12	10	2		7	7			10	8
N	9	1.7	.21	1.5	.26	11	9		1	4	2			8	9
Al	10	1.6	.28	1.2	.22	13	8			5	5			7	8
N	11	1.7	.30	1.4	.29	6	3	2		4	2			10	9
Al	12	1.5	.30	1.1	.10	7	4			7	6			6	9
N	av.	1.7	.35	1.8	.47	Total 65	46	10	2	40	24	1	1	% of un-	7%	20%
Al	av.	1.6	.27	1.3	.26	Total 68	48	6	5	43	34	4		successful tests	14%	17%

stop watch. There were six normal subjects, two figured in the alcohol tests, two in the caffeine tests and two in the tests under normal conditions. These last tests were introduced as a check in order to be sure that the results obtained in the

TABLE II

TESTS WITH CAFFEINE

Subject C

Ca = caffeine tests, N = normal tests

	No.	A		R		A				R				A	R
		R.T.	m.v.	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	4.1[2]	1.1	2.4[2]	.80	8	7	6				2		10	9
Ca	2	2.2	.40	1.5	.10	2	2	7		4	4	5		9	10
N[1]	3	2.2	.40	1.5	.19	4	3	4		2	2	2		9	8
Ca	4	1.8	.33	1.4	.27	4	3	2		4	4	2		8	7
N	5	2.2	.68	1.7	.58	6	6	1	1	3	3			8	8
Ca[1]	6	1.9	.46	1.3	.28	5	5	4		4	4			9	9
N	7	2.2	60	1.4	.18	8	6	5		7	7			9	9
Ca	8	2.0	.34	1.5	.10	5	5	4		4	4			9	9
N	9	1.9	.34	1.3	.14	8	8	3		6	4			9	9
Ca	10	2.2	.56	1.3	.16	4	4	8		4	2	1		10	8
N	11	2.3	.58	1.3	.28	6	4	3						9	8
Ca	12	1.7	.21	1.4	.32	6	6	4		5	3			8	10
N	av.	2.2	.52	1.4	.27	Total 40	34	22	1	18	16	4		% of un-	8%	12%
Ca	av.	2.0	.38	1.4	.21	Total 26	25	29		25	21	8		successful tests	10%	10%

[1] Contains only nine reactions.

[2] Unusually long R.T. due to inexperience and which it was deemed better to omit.

Subject D

	No.	A		R		A				R				A	R
		R.T.	m.v.	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	1.8	.34	1.4	.27	1	1	2	6	1		1	2	10	8
Ca	2	1.5	.14	1.2	.08	12	9	2		3	3		2	9	9
N	3	2.0	.37	1.5	.21	12	9	2		2	1	1		10	9
Ca	4	1.6[1]	.22	1.2	.11	8	7	2		2	2	2		7	9
N	5	1.8	.28	1.7	.44	8	7	7		4	2	2		10	9
Ca	6	2.0	.30	1.7	.45	13	11	4		8	6	1		10	7
N	7	2.3	.50	1.5	.30	15	8	1		2				10	9
Ca	8	2.1	.26	2.2	.50	15	9	6		14	9	1		10	8
N	9	1.9	.27	1.7[1]	.39	13	9			12	11			10	7
Ca	10	1.9	.39	1.8	.50	9	9	3		3	3			9	9
N	11	2.3	.41	1.7	.35	11	8	1		4	4			10	9
Ca	12	1.9	.32	1.7	.32	18	7	2		10	8	1		10	8
N	av.	2.0	.36	1.6	.33	Total 60	42	13	6	25	18	4	2	% of un-	0%	12%
Ca	av.	1.8	.27	1.6	.33	Total 75	52	21		40	31	5	2	successful tests	7%	17%

[1] Contains only nine reactions.

alcohol and caffeine tests were due to the drugs and not to possible differences between the character of the pictures used on drug days and those used on normal days.

Thirty c.cm. of 95 per cent. alcohol in 60 c.cm. of water

were given on alternate test days to the alcohol subjects (Al-subjects). It was taken three quarters of an hour before the test began. This amount of time was required for the alcohol to

TABLE III

TESTS UNDER NORMAL CONDITIONS

Subject E

Dg = those days on which the same pictures were used that were used for the foregoing subjects on drug days. The averages of these days are taken just as if they were drug days.

	No	A		R		A				R				A	R
		R.T.	m.v	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	1.5	.26	1.3	.21									7	6
Dg[1]	2														
N	3	1.3	.15	1.2	.24									8	5
Dg[1]	4														
N	5	1.0	.10	1.2	.40	2	2		1	2	2		2	6	6
Dg	6	1.3	.34	1.9	.12	3	3	2		2	2	2		8	9
N	7	1.2	.19	1.1	.26	4	3	1	3	2	2	1		7	8
Dg	8	1.4	.20	1.1	.16	3	2	4		2	1			8	9
N	9	1.5	.36	1.0	.06	6	6		1	2	2			9	7
Dg	10	1.7	.30	1.1	.10	2	2	1	1	1	0			9	9
N	11	1.3	.22	1.1	.16	4	3	3	2	3	2			9	8
Dg	12	1.1	.12	1.0	.10	5	5		1	4	4			8	8
N	av.	1.3	.21	1.1	.22	Total 16	14	4	7	9	8	1	2	% of un-	23%	32%
Dg	av.	1.3	.24	1.2	.12	Total 13	12	7	2	9	7	2		successful tests	17%	12%

[1] It was impossible to use the data of these days on account of an unforeseen irregularity in the experiment. They would, however, have made no difference in the av. R.T.

Subject F

	No.	A		R		A				R				A	R
		R.T.	m.v.	R.T.	m.v.	k′	k″	v	a	k′	k″	v	a	S.S.	S.R.
N	1	2.7	.88	1.9	.26			3				1		10	6
Dg	2	2.3	.65	1.3	.30	2	2	5	2	5	4	1		8	9
N	3	1.8	.42	1.2	.20	1	1	3	2			3		10	8
Dg	4	1.9	.39	1.5	.23	4	3	5	0	1	1	4	1	9	7
N	5	1.7	.22	1.7	.58	1	1	6		2	1	2		10	6
Dg	6	2.1	.52	1.3	.18	9	4	6				2		10	6
N	7	1.8	.44	1.3	.24	1	1	5		1	1			9	10
Dg	8	1.9	.40	1.6	.30	5	4	7		1	1	3		10	9
N	9	2.3	.48	1.3	.16	3	1	8				1		9	8
Dg	10	1.6	.34	1.4	.10	4	1	7		3	2			10	9
N	11	2.0	.40	1.3	.28	2	2	8						10	7
Dg	12	1.8	.26	1.4	.28			2				1		9	7
N	av.	2.0	.47	1.4	.29	Total 8	6	33	2	3	2	7		% of un-	2%	25%
Dg	av.	1.9	.43	1.4	.23	Total 24	14	32	2	10	8	10	1	successful tests	2%	17%

show sufficient effect. The tests took place in the morning some hours after eating. Six gr. of caffeine in capsule were given on alternate days to the caffeine subjects (C-subjects). Three gr. were taken one and a half hours and three gr. one half hour before the test. On the other test days capsules of sugar of milk were given in order, as far as possible, to avoid suggestion. A like precaution would have been taken with alcohol if a suitable disguise for the alcohol could have been discovered.

Let us first examine the reaction time for the alcohol tests (Al-tests). The average reaction time for association for all the Al-days shows a decrease of 1/10 sec. as compared with the average time for all the normal days (N-days) in the case of both Al-subjects. With this decrease in reaction time, however, there is less success at suppression. One subject has 14 per cent. failures with alcohol to 7 per cent. without. The other 8 per cent. with to 3 per cent. without.

The C-subjects show a greater decrease in the reaction time for association on C-days. The average for the C-days is 2/10 sec. more rapid than for the N-days. As to the quality of the reaction one subject shows an increase of 2 per cent. in failures, the other an increase of 7 per cent.

In the Al-tests the R.T. for reproduction on the Al-days shows for one subject a decrease of 2/10 sec. and for the other a decrease of 5/10 sec. and in both cases there are slightly less failures to reproduce correctly on the Al-day. There is, then, a decided increase in rapidity to reproduce the former association with, if anything, more successful reproduction on the Al-days.

Caffeine, on the other hand, has no effect on the R.T. for reproduction of either subject. The one subject has 2 per cent. less failures, the other 5 per cent. more.

The N-subjects never show a difference of more than 1/10 sec. between the two sets of pictures either in the R.T for association or for reproduction. In the association test there is a decrease of 1/10 sec. for one and the same R.T. for both sets of pictures for the other. In the reproduction one shows the same R.T., the other an increase of 1/10 sec.

As to the failure to suppress, one N-subject shows no dif-

ference, the other one of 5 per cent., between the two sets of pictures. In the reproduction one shows a difference of 8 per cent., the other one of 20 per cent.

The slight differences in the R.T. of the N-subjects seem to show that the noticeable differences in the R.T. for the other subjects are not due to differences in the material used. The differences in the failures between the two sets of pictures are sufficiently great to prevent any other deduction in the case of the other subjects, than that neither alcohol nor caffeine markedly affect the number of failures in suppression or reproduction. This is well to know in the case of the decrease in reproduction time by alcohol and in the association time by caffeine. The tests have been made on too few subjects for any final assertion to be possible, but the results at least suggest that as much as 30 c.cm. of alcohol do not affect to any appreciable degree a control of one's thoughts or speech such as is necessary in the suppression here required, while that amount of alcohol does increase the rapidity without impairing the accuracy of the reproduction of associations recently made. Caffeine has a quickening effect upon thought. The associations are made more rapidly and the power of suppression is not seriously impaired. This is the effect that casual introspection generally attributes to the drug. It has no decided effect on the reproduction.[1]

[1] Aschaffenburg writes in regard to the effect of alcohol: "Eine qualitative Veränderung der Arbeitsleistung wurde durch den alcohol nicht hervorgerufen." ('Praktische Arbeit unter Alkoholwirking,' *Psychologische Arbeiten*, Bd. I., p. 626.) Ach's observation that alcohol causes an "Herabsetzung der Schnelligkeit und der Verkleinerung des Blickfeldes der Wahrnehmung" ('Ueber die Beeinflussung der Auffasungsfähigkeit durch einige Arzneimittel,' *Psychologische Arbeiten*, Bd. III., p. 288) may in part at least account for the lack of decrease in the R.T. for associations with alcohol, for we know that the motor discharge is aided by alcohol. In the reproduction tests, where the pictures are familiar, the influence of alcohol on the perception is not as great, or not sufficient, at any rate, to offset the increase in the rapidity of the motor discharge. It may be that the decrease in the time for the motor discharge, which, of course, would allow the word to be spoken more quickly, is the sole cause of the decrease in the R.T. for reproduction. For the influence of alcohol on the motor discharge see Ernst Rodem: 'Ueber die Dauer der psychischen Alkoholwirkung,' *Psychologische Arbeiten*, Bd. IV., pp. 40–41. Ach says further that "Caffein bewirkt eine geringe Besserung der Auffasung" (ibid.). This may be a cause of the decrease in the R.T. for associations with this drug. From August Koch's and Emil Kraepelin's observation that "Der Ablauf gewohnheitsmässiger Associationen wird durch das

A record was kept of the different types of images as is shown in the tables. It was thought that the drugs might change the type and it was also considered of interest to determine if the different reaction times could be correlated with the different types. The results seem negative. There is in general little difference between the imagery in normal days and drug days and nothing can be deduced from the differences that do occur since the normal subjects show differences as great. As to the correlation of types of imagery with reaction time for association, there is a tendency for those who have much visual imagery to have longer reaction times. This may be observed in subjects C and E. Subject A, however, is an exception. Subject E, who has the least amount of visual imagery, has the quickest R.T.

An examination of the quality of the reaction words has also been made to see if there is a change in the distribution under alcohol and caffeine. It was thought that although there was slight effect upon the actual suppression of the name of the object, yet the quality of the reaction words might perhaps give a clew among other things, to the difficulty of suppression with and without the drugs. A classification was chosen which was expected to bring out any such change in distribution. An increase in the number of descriptive words or of those words caused by suggestion through resemblance might indicate a difficulty to get one's thought away from the picture. An increase in repetition or a change in the number of super-ordinate words, or in the type of reacting under the influence of a drug, would also be of interest. The decision as to whether a word should be classified under contiguity or coördination is, as is well known, often a difficult one. Without introspection it is always a guess.

Turning to the table we find a surprising similarity in the distribution of the words on drug days and normal days. There is, however, one difference of interest. Both caffeine subjects, *C* and *D*, have fewer words from suggestion on C-day. C has a change from 7 to 2 words and D one from 18 to 4.

Caffein erleichtert" ('Ueber die Wirking der Theebestandtheile auf körperliche und geistige Arbeit,' *Psychologische Arbeiten*, Bd. I., p. 488) one would expect that caffeine would quicken the reproduction. This was not the case in our experiments.

TABLE IV

CLASSIFICATION OF ASSOCIATION WORDS

	Subject A			Subject B			Subject C			Subject D			Subject E			Subject F		
	Al	N	Total	Al	N	Total	Ca	N	Total	Ca	N	Total	Dg	N	Total	Dg	N	Total
Descriptive .	2	2	4	8	6	14				1	1	2	3	2	5			
Verb.....	32	35	67	4	1	5	1	1	2	1		1	16	9	25	43	42	85
Contiguous .	14	15	29	25	24	49	41	37	78	18	23	41	3	4	7	1	4	5
Super-ordinate ..				1	3	4				3	1	4	1		1			
Coördinate .				4	4	8	3	4	7	18	13	31	4	2	6			
Repeated...	6	2	8	1	1	3	2	1	3	4	1	5	2	5	7	6	7	13
Suggested ..		2	2	3	2	5	2	7	9	4	18	22	3	8	11	3	3	6

As will be seen there is a tendency for the subjects to react always with a word of the same class; that is, they become stereotyped in the quality of reaction words. In the previous work[1] we mentioned this tendency of one of the subjects to react with verbs. In the present experiments we find two distinct verb types, A and F, and one fairly marked verb type E, two contiguity types, B and C, and one type, D, in which most of the words are divided between contiguity, coördination and suggestion. It is interesting to note that the subject E, who became the least stereotyped, also has the most failures to suppress. We will return to the discussion of these failures later. Subject B, who has the most descriptive reactions, also has a comparatively large number of failures to suppress, which fact in some part bears out the hypothesis that reaction by descriptive words shows a certain difficulty in getting away from the name of the picture. There is no correlation between these types and the reaction times.

Unfortunately the attitude of the subjects in the fore-period was not ascertained at the beginning of the experiment, so that it is impossible to give an account of the development of the consciousness of the instruction during this period. Later, however, the contents of consciousness during the fore-period were occasionally tapped by interrupting the experiment before the picture was exposed and without warning to the subject. It was found that the negative instruction, which was always repeated by the experimenter at the beginning of each series,

[1] P. 206.

continued to 'ring in the ears' of the subjects, during the fore-period of the first test, or was repeated by the subject in its negative form. As a rule after this first test there was nothing in consciousness pertaining to the instruction. The subjects described this attitude as 'passive.' They sat before the shutter and waited for it to open. This expectancy was all that could be found in consciousness. One subject, E, proved an exception. He repeated the instruction in its negative form before almost every exposure. Sometimes this was reduced to 'No, no,' or 'not picture or any part of it.' Several times it was in the form of 'do what you did before.' This is a positive command, whose purpose is to suggest a negative attitude. Beyond the mere repeating of the words of instruction the only representation in consciousness of the negative attitude was a focusing of the eyes on a point beyond where he knew the picture was to appear. It was in this background that he seemed to himself to search for a word, after recognizing the picture, and he felt that this attitude aided him in getting away from the name of the picture. In almost no instance was the negative instruction changed to a positive one. The words touched off a cortical set, which may be called a negative set, in so far as it has an inhibitory effect either upon the thought of the name of the object or its expression in speech. The nature of this set cannot be described further, but that there are two different processes, a positive and a negative one, seems fairly well established.[1] Although little was found in consciousness beyond the words of instruction to represent this negative set, one may hazard a guess that in the early development of the individual there is a characteristic representation, but that, following the laws of habit the process becomes more or less mechanical and is generally limited to physiological processes.

A full description of the process of suppression during the main period is given in the former paper. These experiments furnish no new data. The introspection does, however, throw some light upon the causes of failure to suppress and failures in reproduction as well as some description of the effect of the

[1] See summary of former paper, p. 208.

inhibitory attitude. As the tables show, there were few failures to suppress. Subject E shows the most. He is also the one subject who repeated the instruction before almost every test. When he failed to suppress he generally said that his attitude was not good. Either he had not repeated the instruction or he hadn't the instruction well in hand. There seems to be strong indication here that the subject lacked concentration. In terms of this problem the instruction not only tended to disappear from consciousness as was the case with the other subjects, but the attitude as represented in physiological processes tended also to disappear, so that the instruction had to be repeated. Like indications of lack of concentration were observed in a different experiment conducted by another experimenter in this laboratory.

When there was difficulty in recognizing the picture, the delayed act of recognition with its affective tone seemed to weaken the attitude of suppression and the picture was frequently named. A possible description is that the name of the object is delayed by lack of recognition, and when this recognition occurs the name comes into consciousness with a bound, so to speak, and as the attitude of the instruction had been pushed aside for the moment by the difficult act of recognition, the name comes to utterance.

An emotional state of one of the N-subjects, who had a momentary difference with the experimenter on one of the test-days, also caused an unusual amount of failure. An occasional unavoidable distraction also weakened the attitude. An attempt was made to conduct similar experiments under conditions of distraction, but it was found that distraction, such as is produced by noise, odors, mental work, or emotional states could not be made subject to the will of the experimenter.

As regards the failure to reproduce the previous association, one of the chief causes is the fact that there were several images in consciousness before the one given in the association test. In the reproduction test that followed, one of these images, and not the one actually given as an association, was then reproduced. For example: association "BRUSH—*hair*. Recognized brush. Kin. image of brush. Active suppression.

Visual of side of horse with brush on it. Then hair." Reproduction '*brush—horse.*' There were also instances of the reproduction of a word that had just preceded instead of the correct word.

Varied effects of the inhibitory process could be observed in the introspection. At times a certain perception was suggested by the shape of the picture. As soon as it was seen not to be the name of the picture, this perception was given as an association, even though the object itself may not have been fully recognized. For example: association "CARPET-SWEEPER—*typewriter.* Started to recognize typewriter. Saw it wasn't. Said typewriter." Association "RATTLE—*hair.* Percept slow in forming. After slight pause hair came. Suggested by picture although I knew it wasn't that." Association "RAT—*dog.* Recognized it wasn't dog. Looked so much like it that I said dog. Then recognized rat." Here is also an example where the name would not come. Associaton "BATH-TUB—*bowl.* Percept came somewhat slowly. Tried to get name but couldn't. Then came word bowl. The form suggested bowl." Even when the association is not by suggestion the name may be held up until after the association, both in association and reproduction tests. Association "BLOCK—*axe.* Axe came immediately. Afterward chopping block," or reproduction "PITCHER—*water.* Water came automatically. Kin. of pitcher afterward."

There are also instances where the inhibitory process instead of inhibiting the name of the object gives it a different meaning, attaching the word to imagery sometimes quite different from the picture. This very frequently occurs with verb associations; for example, association "FLY (noun)—*fly* (verb). Its wings were prominent," or association "BRUSH (noun)—*brush* (verb). Recognized brush. Visual image of brushing." Association "SMALL TENT—*circus tent.* Thought of that tent, then large circus tent." Association "LADDER—*step.* Aud. ladder. Persisted a short time. Made visual image of step to a house. Then said step."

Tests on Insane Subjects

Tests of a nature similar to the above were made upon dementia præcox and manic depression cases at the Danvers State Hospital.[1] A similar instrument and sixty of the cards used in the first series of normal tests were employed. Introspection was not required, inasmuch as there would always be grave questions as to its reliability. The instructions were those of the first normal tests and did not include prohibition to name a part of the picture. There were eight dementia præcox, three manic and one depression patient.

Table V

Tests on Dementia Præcox and Manic Depression

No. = number of tests, F.S. = number of failures to suppress, F.R. = number of failures in reproduction.

Subjects		A Tests			R Tests			F.S.	F.R.	Classification of Association Words						
		No.	R.T.	m.v.	No.	R.T.	m.v.			Des.	v.	Con.	Sup.	Coö.	Re.	Sug.
Dementia Præcox	H	58	3.3	1.56	58	1.5	.33	19	7	1		20	20		5	
	R	51	6.4	3.07	42	4.5	2.14	51	60	6	1	7				
	Ah	58	4.9	2.23	58	1.8	.65	0	7			27	13	3		4
	Cu	47	5.5	2.59	47	1.9	.54	21	9	10	4	10	6		1	
	S	58	3.2	1.56	58	1.9	.66	2	7	4	18	24	3	2		
	M	56	3.7	1.05	56	2.5	.90	0	9		1	43			1	1
	Ch	57	2.1	.76	56	1.1	.25	9	5	2	3	34	2	2		
	T	55	2.8	.92	55	1.3	.23	11	14	7	5	14	7	2		
Depression	N	58	4.5	2.03	58	1.9	.65	5	12	2	16	15	15			
Manic	E	55	2.3	.75	55	1.5	.35	5	5	2	1	34	11		4	
	Al	40	3.4	1.29	40	2.9	2.20	0	7	31	1	6				
	G	39	1.2	.38	39	.75	.13	3	0	3	29	6				

From the table we see that the reaction times for association are in all but two cases longer than for any of the normal subjects—in many instances longer than could be accounted for by a difference in education. These long R.T. occur both for dementia præcox and manic depression. Among the manic depression the manic type is more nearly normal. One showed an unusually rapid reaction time. As regards the R.T. for reproduction in all but three cases it closely resembles that of the normal subjects. Many of the m.v. are extremely large.

As regards suppression, the three cases which show many

[1] The author takes this occasion to thank the physicians of the hospital for their kindness in permitting and facilitating these tests.

failures are all dementia præcox. One has a very great many failures, the others have more than the normal subjects with the exception of normal subject E, who had most of his failures during the emotional disturbance. The one patient with the largest number of failures also has the largest number of failures to reproduce the correct word.

The fact that all the large number of failures to suppress are by dementia præcox patients seems to corroborate the theory that an impairment of the will in which a decrease in attention plays an important part, is a characteristic feature of this disease.[1] The lack of retentiveness in the case of one dementia præcox patient seemed to be a special feature of the case not found in any of the others. In her case the symptoms of dementia were much more marked.[2] A dementia præcox patient not recorded named the object at every exposure. He showed a willingness to take part in the experiment and whether his failure to suppress was due to any difficulty upon his part to restrain from uttering the name or from a negative attitude toward the experiment could not be decided.

These subjects also show distinct types of reaction as regards the quality of the reaction word. Most were of the contiguity type, one was distinctly of a verb type, two showed many superordinate words and one was decidedly of a descriptive word type.

Summary

As was mentioned above, there were too few subjects to permit of any generalization. Several interesting possibilities, however, were suggested by the results.

1. 30 c.cm. of alcohol caused a decrease in the reaction time in the reproduction tests. It did not appreciably affect the suppression or accuracy of reproduction.

[1] Alfred Busch, 'Auffassungs- und Merkfaligkeit bei Dementia Praecox,' *Psychologische Arbeiten*, Bd. V., p. 336.

[2] Dr. Charles Ricksher remarks in regard to the retentiveness of dementia præcox patients, " . . . when cases are arbitrarily classed according to the apathy they show, the duration of the disease, etc., those showing the more marked deterioration almost invariably show less ability to recall either the auditory or visual stimuli than do those with a slighter degree of dementia." ('Impressibility in Dementia Præcox,' *American Journal of Insanity*, Vol. LXVI., No. 2, p. 229.)

2. Caffeine caused a decrease in the reaction time for association and showed no appreciable effect upon the suppression or accuracy of reproduction.

3. Introspection on the fore-period showed no evidence of the necessity of translating negative into positive instruction. This makes it probable that there is a distinct negative as well as positive attitude, which in most instances can be described solely in terms of cortical set.

4. The lack of a power of suppression was found only in some of the dementia præcox patients. The manic depression patients were normal in this respect. Accuracy of reproduction was normal in both dementia præcox and manic depression with one exception (dementia præcox).

THE HYGIENE OF SLEEP

BY E. C. ROWE

This study was undertaken for the purpose of determining if possible whether any *direct* relation exists betweeen the *amount* of sleep and the barometric conditions and also between the amount of sleep and the number of hours spent in mental work. A correlation has also been attempted between the *amount* of sleep and general feeling-tone. For this purpose a daily record was kept of the number of hours and minutes of sleep and also of the number of hours and minutes of work. Of course the time of sleep cannot always be exactly determined for the very evident reason that one cannot be sure just when he went to sleep. This inaccuracy is, however, reduced to a minimum if one falls asleep quickly upon retiring, as was the rule with the subject of the study. A watch was kept at hand so that in case he awakened during the night the time might be noted. The subject was soon able to estimate the time during which he was awake quite closely. This was determined on various occasions by estimating the duration of wakefulness after noting the time of awaking and then comparing the estimate with the actual time that had elapsed. On the whole, he feels confident that the time of actual selep was obtained within an average inaccuracy of ten or fifteen minutes.

The work record was limited to work done in connection with university studies. The feeling record from which the curve is constructed was kept by a second party and was based upon observation and reports by the subject. This curve is naturally less accurate than the others both so far as the *amount* of the deviations from an assumed mean are concerned and also with regard to the actuality of the deviations. This is not, however, to be interpreted as an admission that the curve is untrustworthy. In the main it is correct. One can tell how he feels from day to day, but when one undertakes to express these feeling conditions in terms of a curve slight inaccuracies may

creep in, especially when the feeling conditions are quite similar for several days in succession. It is the writer's judgment, however, after six months of observation, that our general psycho-physical tone changes more from day to day than the average person is aware of.

The record was begun in October, 1907, and continued without interruption up to the spring recess, April, 1908. The sleep record of a two and one-half year old boy living in the same house and under the same general conditions as the adult subject, was kept for the same period for comparative purposes and is correlated with the barometric curve in chart 2.

The objection may be raised that the keeping of such a record is likely to influence one's habits of sleep and work and thus vitiate the object of the study. To concede that it did have some unconscious influence is by no means to admit that such influence destroys or even interferes at all seriously with the significance of the results. While it did here and there lengthen the period of wakefulness this disadvantage was probably more than offset by the subject's extra precaution with regard to diet and general living habits throughout the period. Sleep is probably influenced by a wide range of stimuli and conditions all the way from the condition of digestion, nerves and muscles up to the last psychic process preceding sleep. The addition of one minor factor may be counterbalanced by the suppression of another.

With certain brief exceptions due to illness, the subject's habits of sleep have, so far as he remembers, always been good, going to sleep quickly and sleeping soundly. He has always slept from seven to eight hours, retiring moderately early and arising rather early. Throughout the period for which the record was kept the subject was the only occupant of a large third-floor sleeping room on an unusually quiet street. The room was always flooded with fresh air before retiring and kept cool throughout the night by direct ventilation through an open window. The hours of retiring varied from nine to eleven o'clock. The controlled conditions were therefore favorable to good sleep.

The records were begun on October 22, 1907, and continued

for 162 days. The sleep, work and feeling data were of course recorded each day. The barometric data were obtained from nearby observatories. Probably no better place or time could be chosen in which to study the relation of barometric changes to sleep than a New England winter with all its weather contrasts. Surely if any correlation exists between the two it should come out in the frequent and sharp changes incident to such a winter. Especially should this be true for the two subjects whose sleep records were kept inasmuch as neither one had ever before spent a winter in New England and hence was in no sense acclimated to the peculiarities of local conditions.

The accompanying curves, based upon these records, are, so far as possible, drawn to the same scale. Work and sleep, measured in terms of hours, are constructed upon the same scale, but barometer and feeling are necessarily based upon distinct measurements. But this in no wise renders impossible the comparison or correlation of any one of the curves with any or all the others. Their comparison and possible correlation are here considered from two points of view. First, the curves are compared with each other with regard to the direction in which they move for the successive days. Second, they are compared with regard to the amount of deviation from their respective averages.

In comparing the curves with reference to the direction in which each is moving in relation to another, *three* possibilities are considered, namely, that they may move in the same general direction (though of course not necessarily parallel any or all the way); that they may diverge; and thirdly that they may cross each other. With these three possibilities under consideration the following results are obtained from the adult curve:

1. Sleep and work (Sundays excepted) ..... 133 days.
   (*a*) In same general direction ..... 81 days.
   (*b*) Sleep up; work down ..... 29 days.
   (*c*) Sleep down; work up ..... 24 days.
2. Sleep and barometer ..... 162 days.
   (*a*) In same general direction ..... 78 days.

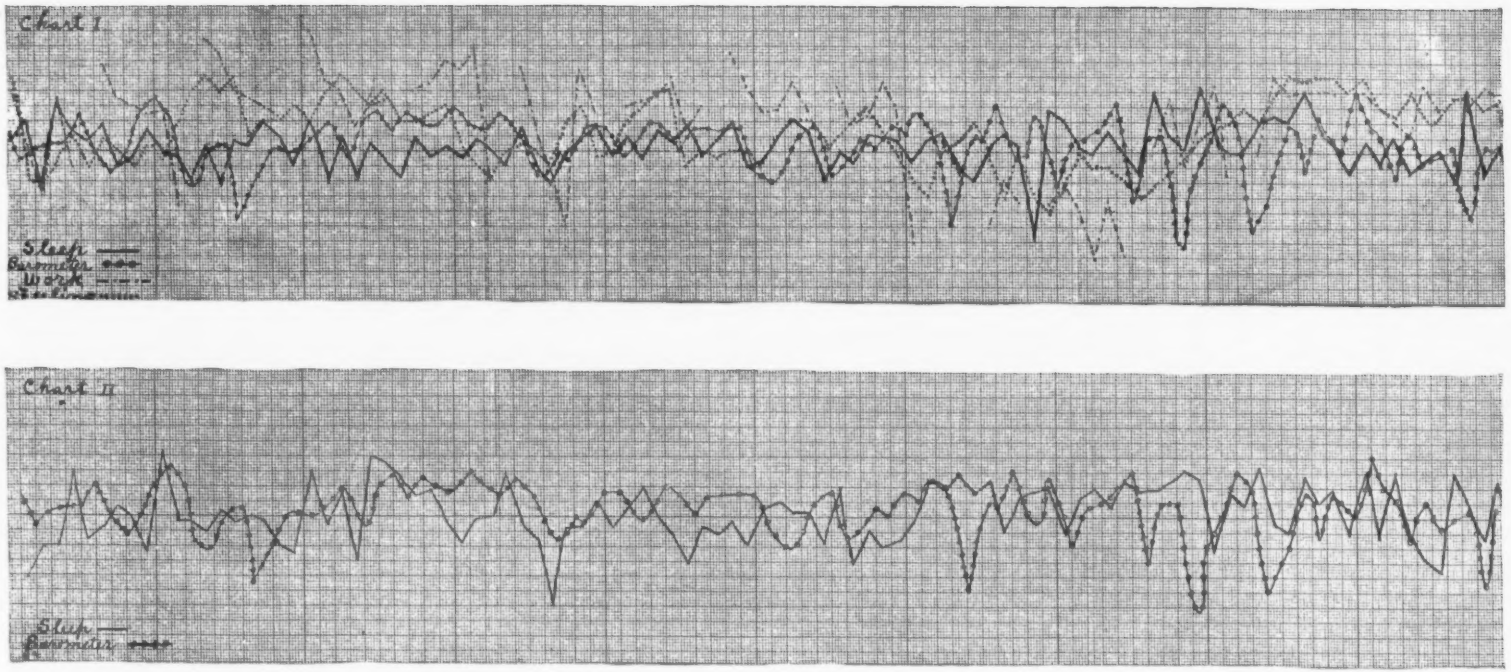
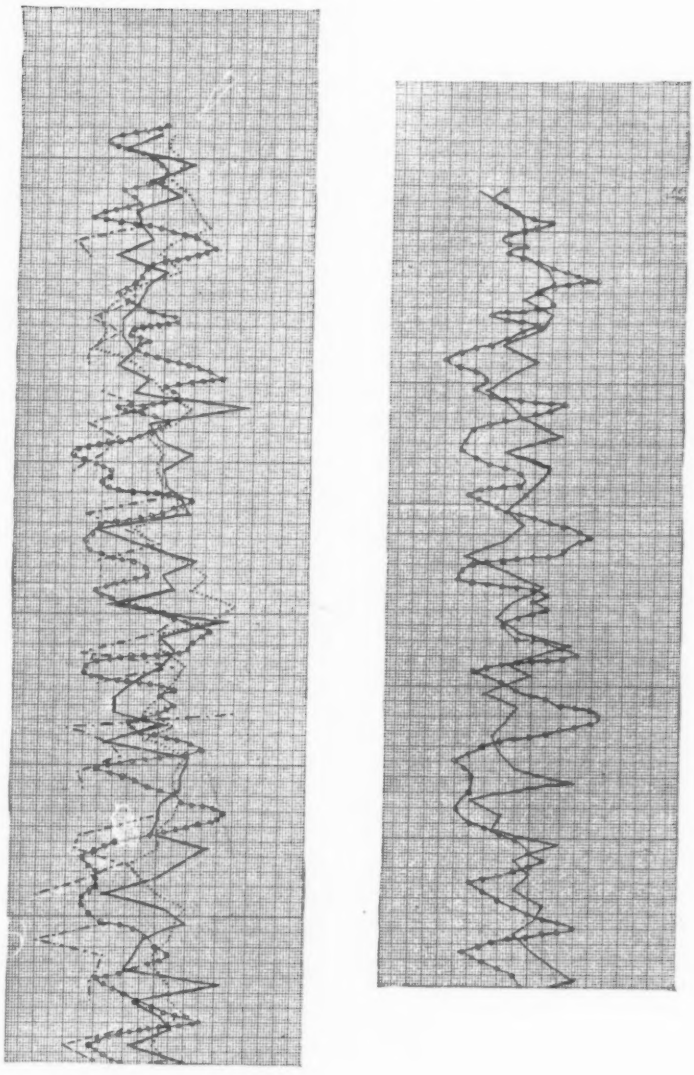


Chart I
Sleep
Barometer
Work
Chart II
Sleep
Barometer



(*b*) Sleep up; barometer down . . . . . 39 days.
(*c*) Sleep down; barometer up . . . . . 45 days.
3. Sleep and feeling . . . . . 162 days.
(*a*) In same general direction . . . . . 99 days.
(*b*) Sleep up; feeling down . . . . . 23 days.
(*c*) Sleep down; feeling up . . . . . 40 days.

4. Work and barometer (Sundays excepted) .133 days.
   (*a*) In same general direction . . . . . 71 days.
   (*b*) Work up; barometer down . . . . . 20 days.
   (*c*) Work down; barometer down . . . . . 42 days.
5. Work and feeling (Sundays excepted) . . . . . 133 days.
   (*a*) In same general direction . . . . . 89 days.
   (*b*) Work up; feeling down . . . . . 14 days.
   (*c*) Work down; feeling up . . . . . 30 days.
6. Barometer and feeling . . . . . 162 days.
   (*a*) In same general direction . . . . . 85 days.
   (*b*) Barometer up; feeling down . . . . . 42 days.
   (*c*) Barometer down; feeling up . . . . . 35 days.
7. Average number of hours of sleep = 7 hrs. 1 min. M.V. = 52 min.
8. Sleep and barometer (child's record) . . . . . 150 days.
   (*a*) In same general direction . . . . . 94 days.
   (*b*) Sleep up; barometer down . . . . . 30 days.
   (*c*) Sleep down; barometer up . . . . . 26 days.
9. Average number of hours of sleep = 12 hrs. M.V. = 40 min.

The curves representing these figures graphically are given on page 428.

The indices of correlation using the 'Whipple' method (cf. *Am. J. Psy.*, Vol. 18, p. 322) found from these figures are as follows:

Sleep and barometer (adult) = − .156.
Sleep and work (adult) = − .031.
Sleep and barometer (child) = + .156.

It was thought that a possible correlation might be found between the variations of sleep and the variations of the barometer on those days when the latter varied over and above an assumed constant variation beyond its average. This constant will here be called 'one.' The adult sleep curve falls below its average six times when the barometer is one or more above its average, but 71 times it is up to or above its average when the barometer is one or more above its average. This gives an idex of correlation of − .951. The child sleep curve

falls below its average 24 times when the barometer is one or more above its average and rises to or above its average 34 times when the barometer is one or more above its average. This gives an index of correlation of − .248.

With regard to the relation between amount of sleep and amount of work, the data may be considered from still another

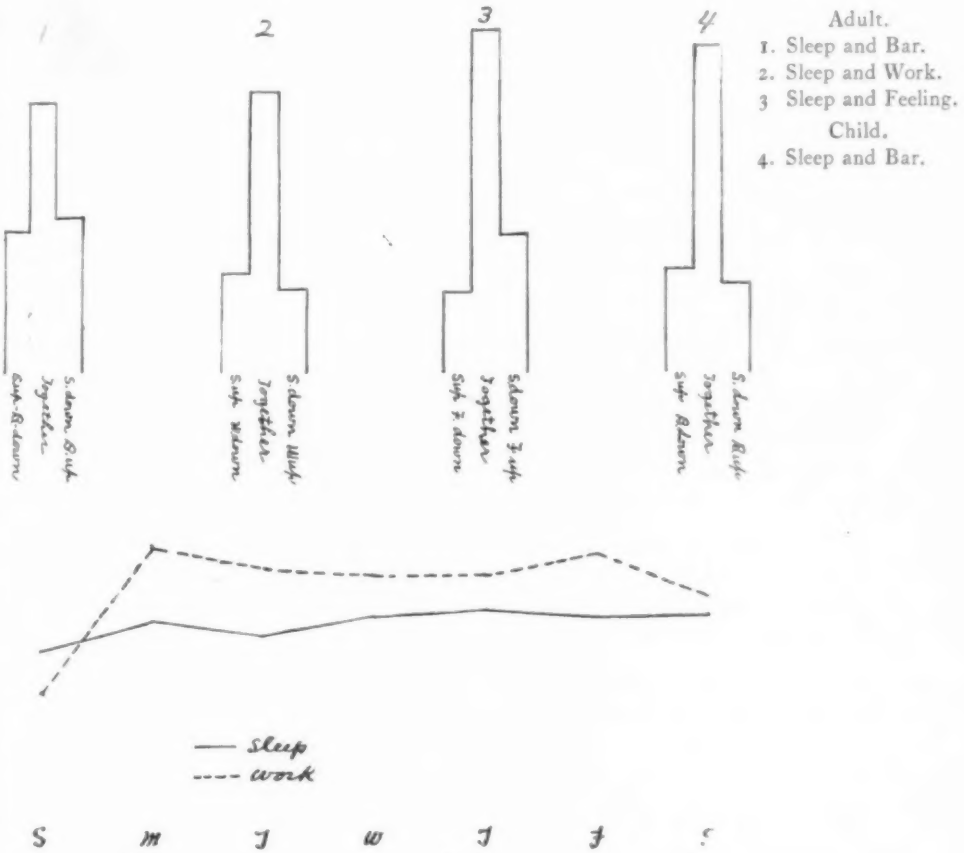


FIG. 1.

point of view. They may be cast into curves representing the average variations of sleep and work for the seven days of the week. When compared these curves show that the work curve is highest on Monday and Friday and lowest on Sunday when it falls to a trifle less than one half its average. The sleep

curve on the other hand falls to its lowest on Sunday night and rises to its highest on Thursday night. (See Fig. 1.) It will be seen therefore that excepting Sunday the sleep and work curves sustain inverse relations, the one rising when the other falls.

All of the attempted correlations with one exception point clearly to one conclusion, namely, that so far as these two persons are concerned there is no direct correlation between the *amount* of sleep and barometric conditions nor between *amount* of sleep, within certain limits, and amount of work. The one exception is presented by the large negative correlation between the adult sleep and barometric conditions when the barometer is considerably higher than its average. This exception is, however, explained in part, at least, by the fact that the notes on daily feeling-tone and quality of sleep (so far as the latter could be determined by the subject's judgment each day) indicate that the correlation between *quality* of sleep and high barometer is not nearly as close as that between the *amount* of sleep and high barometer for the seventy days in question. It is moreover probable when considered in the light of the lack of correlation between deviations from the average of sleep and barometer in case of both adult and child data, that this single correlation, just the opposite to common expectation, would be corrected by more observations.

Of course no general conclusion can be drawn from these limited data; but so far as their indication goes they tend to show that in the evaluation of sleep and its correlation with psycho-physical activities, barometric and environmental conditions, one of the prime considerations is the *quality* of sleep and not its amount. The amount is doubtless highly important when certain limits are transgressed, but *within* these limits we believe the central consideration is *quality* and not *quantity;* that unfavorable environmental conditions and disturbed physiological processes make themselves felt in a change of the quality of sleep before the change in quantity is apparent.